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APPLIED SCIENCES

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FINITE ELEMENT EXPLICIT ALGORITHM FOR SOLVING TEMPORAL TEMPERATURE FIELDS

[English abstract of article by Huang Zhenzhong [7806 2182 0022] of the China Aerodynamic Research and Development Center, Mianyang, Sichuan]

[Text] Practical calculations and numerical experiments in this paper show that in elements relating to a common node it is acceptable and reasonable for derivatives of temperature with respect to time on these nodes to be be presented with one common node if the linear interpolation shape function is taken. The relationship between the derivative of temperature to time on a certain node and the temperature on other nodes around that node may therefore be established after discretization of the differential equation is made in space by the finite element method. Then an explicit scheme for calculating the temperature fields may be constructed. The algebraic equations obtained are simple and the procedure is straightforward, which are its two tangible advantages, and the calculating will, therefore, be fast. The stability analysis by the maximum principle, as in the example quoted, proves that the stability condition is similar to that in implicit algorithms.

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METHOD FOR FINDING PRINCIPAL MODES OF NONLINEAR VIBRATION SYSTEMS AND THEIR STABILITIES

[English abstract of article by Liu Liansheng [0491 3550 3932] and Huang Kelei [7806 0344 4797] of Beijing Institute of Aeronautics and Astronautics; Huo Quanzhong [7202 2164 1813] of Tianjin University]

[Text] This paper presents a new method for finding the principal modes of nonlinear vibration systems by means of which the problem of finding principal modes of nonlinear systems is transferred to the problem of finding real roots of a set of algebraic equations. The method is applicable to various kinds of nonlinear vibration systems with many degrees of freedom, and is simple in calculation. The paper presents another new method for analyzing the stabilities of principal modes of nonlinear systems.

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FURTHER STUDY OF RELATION OF VON KARMAN EQUATION FOR ELASTIC LARGE DEFLECTION PROBLEM AND SCHRODINGER EQUATION FOR QUANTUM EIGENVALUES PROBLEM

[English abstract of article by Shen Huichuan [3088 1920 1557] of the Fundamental Physics Center, University of Science and Technology of China, Hefei]

[Text] This work is the continuation and improvement of the discussion in previous articles. The authors also improve work on the elastic large deflection problem with the results of this paper. They again simplify the von Karman equation for elastic large deflection problems, and turn it into the nonlinear Schrodinger equation. The authors also expand the AKNS equation to a still more symmetrical degree under many dimensional conditions. Due to the connection between the nonlinear Schrodinger equation and the integratability condition for the AKNS equation or the Dirac equation, the authors obtain the exact solution for the elastic large deflection problem by the inverse scattering method. In other words, the elastic large deflection problem becomes wholly a quantum eigenvalues problem.

The large deflection problem with orthorhombic anisotropy is also deduced in this paper.

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SHELL EFFECT AND ODD-EVEN EFFECT IN TRANSITION MATRIX ELEMENT OF TWO-BODY
RESIDUAL INTERACTION

[English abstract of article by Cheng Yehao [5935 2814 3185], et al., of the
Institute of Atomic Energy, Beijing]

[Text] The energy spectra and angular distributions of ^{63}Cu, ^{59}Co and ^{54}Fe
(α,p) reactions of E_α = 26MeV are measured. The experimental results are
reproduced quite well by using the exciton model. From the experimental
results, in addition to the shell effect in pre-equilibrium emissions of the
(α,p) reaction, it seems that there is also a shell effect and odd-even effect
in the transition matrix element of two-body residual interaction. It is
predicted that there is a pairing effect in the pre-equilibrium emissions of
the (α,p) and (α,n) reactions at the lower excitation energy.

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STUDY OF p-p QUASI-FREE SCATTERING IN REACTION D(p,pp)n

[English abstract of article by Liu Genbao [0491 2704 1405], et al., of the Institute of Nuclear Research, Chinese Academy of Sciences, Shanghai]

[Text] The p-p quasi-free scattering cross section in the reaction D (p,pp)n is measured. The energies of incident protons are 7.3, 14.5 and 16.5 MeV. The plane wave impulse approximation (SIA) and modified plane wave impulse approximation (MSIA) are used to fit the experimental data. Reasonable agreement between the data and the calculations is obtained. The cutoff radii of the deuteron wave function (MSIA) are 8.35, 5.5 and 5.5 fm, respectively, for the above energy levels.

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PION ELASTIC SCATTERING ON ^{12}C AND ^{40}Ca AT 800 MeV/c

[English abstract of article by Chen Kezhong [7115 0668 0022] of Guangxi University, Nanning; Liu Xianhui [0491 2009 6540] of the Institute of High Energy Physics, Chinese Academy of Sciences, Beijing]

[Text] Based on the multiple scattering Eikonal approximation, recent data involving the pion elastic scattering on ^{12}C and ^{40}Ca at MeV/c are analyzed. The results show that the Coulomb effect not only enhances the differential cross section at small angles, but also fills up the dip of the differential cross section. Theoretical results are in agreement with the experimental data.

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SOME PROBLEMS IN NEGATIVE RADIO-FREQUENCY QUADRUPOLE ACCELERATORS

[English abstract of article by Zhao Zhiyong [6392 2535 0516], et al., of the Institute of Atomic Energy, Beijing]

[Text] Some problems involving the design and characteristics of a negative radio-frequency quadrupole (RFQ) accelerator are discussed, and a design procedure of the RFP is explored to accelerate a variety of particles. The advantages and disadvantages of the K-T design method and linear design method are studied. A computer program, RFQSBDS, is described at the end of the paper.

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THIRD ORDER TRANSPORT THEORY OF SIX-DIMENSIONAL STATISTICAL BEAM PHASE SPACE

[English abstract of article by Liu Chunliang [0491 4783 0081], et al., of Xi'an Jiaotong University]

[Text] The transport theory of a charged particle beam in nonlinear systems is investigated by the moment method. Effects originating from the system misalignments, second, and third order aberrations are taken into account. The third order transfer equations of six-dimensional statistical beam phase space are derived. The results given here may be used to design beam transport systems of high precision.

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DEVELOPMENT AND APPLICATION OF ATOMIC COLLISION SYSTEM

[English abstract of article* by Jiang Zengxue [5592 1073 1331], et al., of
the Institute of Nuclear Science and Technology, Sichuan University, Chengdu]

[Text] A high-resolution multi-function experimental system for studying atomic
collision physics has been built at the Institute of Nuclear Science and Tech-
nology of Sichuan University. In this paper, the structure, function and
specifications of the experimental system are described. The total relative
energy resolution is $\pm1.5 \times 10^{-4}$. The overall angular resolution is $\pm1.5 \times 10^{-4}$ rad. The beam line pressure is $(266-933) \times 10^{-7}$ Pa. The system is used
to study the interaction of fast molecular ions with solid targets. The
experimental results are discussed briefly.

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OPTICAL PHONONS, PLASMON AND LO PHONON-PLASMON COUPLING MODE IN MIXED
CRYSTAL $GaAs_{1-x}P_x$ GROWN BY LIQUID PHASE EPITAXY

[English abstract of article by Lu Wei [7120 5898], et al., of the Laboratory
for Infrared Physics, Shanghai Institute of Technical Physics, Chinese Academy
of Sciences; Fang Zhilie [2455 1807 3525], et al., of Fudan University,
Shanghai]

[Text] The far infrared reflection spectra of $n-GaAs_{1-x}P_x$, with x = 0.328 and
x = 0.40, are investigated in the frequency range of 40-700 cm^{-1} and the
temperature range of 4.2-300K. The important physical parameters describing
the optical phonons, plasmon and LO phonon-plasmon coupling mode of the
material and infrared optical constants are obtained by the multioscillator
fitting and K-K relation calculation. A model of a two conduction band valley
with a donor level below and associated with an X minimum is presented to
explain the behavior of the dependence of the plasmon frequency on the
temperature and the variation of the three coupling modes with temperature.

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STUDY OF CRITICAL CONDITION OF LASER RECRYSTALLIZATION FOR POLYCRYSTALLINE SEMICONDUCTOR FILM ON INSULATING SUBSTRATE

[English abstract of article by Leng Jingming [0397 7234 3047], et al., of the Department of Physics, Fudan University, Shanghai; Lin Chenglu [2651 2052 7627], et al., of the Shanghai Institute of Metallurgy, Chinese Academy of Sciences]

[Text] For polycrystalline semiconductor film deposited on an insulator and then recrystallized by a laser beam, the influence of the substrate upon recrystallization of the film has been analyzed theoretically. The authors found the critical laser power necessary for the solid-liquid phase transition to take place will change to a lower value as the poor thermal conduction of the insulating substrate is considered. It is well known that the existence of stress in recrystallized films may be taken as a criterion for the melting process that is experienced during laser irradiation. A large number of SOI samples prepared by LPCVD technology were studied after its laser recrystallization to obtain the critical transition conditions through stress determination by use of Raman peak shifts. A comparison of the calculations based on the model taking low thermal conductance of the substrate into account with the experimental results showed its fitting is better than that in which the influence of the substrate is neglected.

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STUDY OF AS-GROWN SWIRL DEFECTS IN CZ SILICON CRYSTAL

[English abstract of article by Duan Pei [3008 3099], et al., of the Institute of Analysis and Measurement, Hunan Province, Changsha]

[Text] The oxide precipitates (1000-6000 Å) were separated from as-grown CZ silicon crystals containing swirl defects by means of the chemical etching method. The selected-area electron diffraction analysis of the precipitates, which had been prepared in the extraction replica specimens, was carried out in TEM. Simultaneously, the morphology of the swirl defects in silicon thin foil specimens was observed with TEM, thereby establishing the corresponding relationship between the particles in the extraction replicas and the swirl defects in the silicon thin foils. It was concluded that a great number of the swirl defects are keatite (silica k) in the form of square-shaped platelets with {100} habit planes and sides in parallel with the <110> direction, and a small part of the swirl defects are α-cristobalite in the form of hexagonal platelets with {111} habit planes and sides in parallel with <110>. The IR absorption spectra of as-grown CZ silicon samples showed that the square plate-shaped keatite was probably associated with the absorption band at 1224 cm^{-1}.

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PARAMETER CHOICE FOR LASER BEAT-WAVE ACCELERATOR

[English abstract of article by Yu Wei [0151 3837], et al., of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Text] The three-wave interaction in a laser beat-wave accelerator are studied. The authors find that with the parameters of $\sigma = \omega_p/(\omega_1 - \omega_2)$ and $\beta = \omega_2/\omega_1$ properly chosen (where ω_p, ω_1, ω_2 are the plasma frequency and frequencies of the two laser beams respectively), the required large-amplitude plasma wave will be excited even though the incident laser beams are relatively weak. As a result, the injected electrons will receive a significant energy gain.

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BOUNDARY COUPLING EFFECTS OF LATTICE VIBRATION IN ACOUSTIC BRANCH

[English abstract of article by Li Jingde [2621 2529 1795] of the Department of Physics, Zhongshan University, Guangzhou]

[Text] Taking into account the two- and three-body interaction of the nearest neighbors, the acoustic modes of the N x N square lattice are solved in harmonic approximation. The boundary coupling effect leads to physical pictures of phonons differing from those in the infinite lattice. The standing wave phonons can only be classified according to space species, and the wave vector loses its sense. Numerical computation shows that the strengthening of the covalent property leads to the appearance of a boundary coupling soft mode. The modes relating to rotation, inner-rotation, C/I structure and surface wave phonons are also given. The phonon spectrum of the finite lattice extends to the lower and higher ends. The effects in three-dimensions are also considered.

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HALL EFFECTS AND SUPERCONDUCTIVITY OF AMORPHOUS InSb AND ITS METASTABLE INTERMEDIATE PHASES IN PROCESS OF CRYSTALLIZATION PHASE TRANSITION

[English abstract of article by Cao Xiaowen [2580 2400 2429], et al., of the Institute of Plasma Physics, Chinese Academy of Sciences, Hefei; Zhang Yuheng [1728 5940 1854] of the Department of Physics, University of Science and Technology of China, Hefei]

[Text] Hall effects of amorphous InSb and its metastable intermediate phases which appear in the process of the crystallization phase transition have been studied. Experimental results show that the conduction of the electron is dominative in the metal-type amorphous InSb, and the conduction of the hole is dominative in the semiconductor-type amorphous InSb. The first jump of the conductance is a process involving the structure relaxation from the liquid-like amorphous state to the lattice-like one; the third jump of the conductance is caused by In-Sb solid solution with the rich In or rich Sb being separated out and segregated on the grain boundaries. The three types of crystallization phase transition of the metal-type amorphous InSb present obviously different behavior in transportation. The rise of the super-conducting T_c of the metastable crystalline metallic phase, which corresponds to the peak of the second jump of the conductance, possibly originates from the increase in electron concentration.

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ON ULTRAVIOLET-VISIBLE ELLIPSOMETRIC SPECTRA OF As+ IMPLANTED SILICON

[English abstract of article by Jiang Renrong [3068 0117 2837], et al., of the Microelectronics Research Institute, Zhongshan University, Guangzhou]

[Text] The radiation damage and annealing behavior of $1 \times 10^{16} - 3 \times 10^{12}/cm^2$ As+ implanted silicon have been measured with a TPP-1 spectroscopic ellipsometer. The results are as follows: (1) The amorphous layers were formed on the surface of Si samples when the doses of implanted As+ were higher than the critical value. When the doses were smaller than the critical value, both the $n-\lambda$ and the $\varepsilon_2-\lambda$ curves for As+ implanted silicon shifted downward with an increased dose of implanted As+. (2) With annealing at 700°C, the $n-\lambda$ curve and $\varepsilon_2-\lambda$ curve in the spectra range of 4000-7000 Å of As+ implanted silicon exhibited the behavior of single crystalline silicon. However, in the range of 2700-4000 Å, the curves did not show crystalline silicon behavior, and the difference between these curves and those taken with crystalline silicon increased with the doses of implanted As+. (3) The dose dependence of the radiation damage has been obtained.

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ATMOSPHERIC ATTENUATION OF NEAR INFRARED RADIATION PROPAGATING THROUGH FOG

[English abstract of article by Song Zhengfang [1345 2973 2455], et al., of Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Text] Based on the measurement data of the real atmosphere, the attenuation properties of near infrared radiation of GaAs LED propagating through fog are discussed. Comparisons of the attenuation coefficient with the simultaneously observed meteorological visibility show that there is a close relationship between them. This conclusion is proved by the theoretical calculations.

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PREPARATION OF FLUORIDE IR OPTICAL FIBERS WITH HIGH NUMERICAL APERTURE

[English abstract of article by Cao Yuan [2580 0337] of the Graduate School,
Zhejiang University; Gan Fuxi [1626 4395 3588] of Shanghai Institute of Optics
and Fine Mechanics, Chinese Academy of Sciences]

[Text] In preparing fluoride IR optical fibers with high numerical apertures
(N.A. - 0.427), a new approach toward selecting the compositions of the core
and cladding glasses is presented. Preforms with step-structured refractive
indices are prepared. Optical fibers are drawn in a conventional furnace.
Factors affecting the quality of optical fibers are analyzed based on the
experimental measurements.

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ANALYSIS OF RING CAVITY OPTICAL BISTABLE SYSTEM WITH SINGLE OUTPUT

[English abstract of article by Luo Liguo [5012 0448 0948] of the Department
of Optics, Shandong University; Chen Jishu [7115 4949 6615] of the Department
of Physics, Ningbo University]

[Text] The ring cavity optical bistable system with single output is presented
and analyzed. The steady state equation in the purely absorptive and resonant
condition is given. The steady state curves in the mean field limit all
exhibit a reverse "S" shape, and the critical value of the bistable cooperative
coefficient C is equal to 2. The central section of the reverse "S"-shaped
steady state curve proves to always be unstable. In addition, part of the
steady state curve on the right-hand side of the central section may also lose
its stability.

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ENGINEERING DESIGN METHOD AND EXPERIMENTAL CHECKING OF DIFFRACTION RADIATION
OSCILLATOR

40090011 Shanghai HONGWAI YANJIU [CHINESE JOURNAL OF INFRARED RESEARCH]
in Chinese Vol 6A No 4, Aug 87 pp 283-290

[English abstract of article by Yu Shanfu [0060 0810 1133], et al., of
Chengdu Institute of Radio Engineering]

[Text] An engineering design method of a diffraction radiation oscillator
is given in detail. It covers the designs of the open cavity, reflection
diffraction grating, electron efficiency, operating voltage and current,
and starting current. The above-mentioned designs are verified satisfactorily
by experiments. In the range of 2000 to 4000 volts, the microwave oscillatory
power is measured in the 60-87 GHz band. The maximum output power is 800 mw.
The minimum starting current is 30 mA. These results are better than those
obtained by the United States Army Electron Research and Development Command,
Harry Diamond Laboratories.

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STUDY OF HIGH TEMPERATURE INFRARED RADIATION MATERIALS OF MnO_2-CoO-CuO

[English abstract of article by Zhang Changrui [1728 7022 3843], et al., of the National University of Defense Technology]

[Text] The effects of thermal treatment temperature on the emissivity of high temperature infrared radiation materials of MnO_2-CoO-CuO are studied in this paper. With different thermal treatment temperatures, the changes in x and y in $(Co_xMn_{1-x})(Co_yMn_{1-y})_2O_4$ and of the content are found to be equivalent to the effect of impurities, making the radiation band change at approximately 3 µm. This effect and the anharmonicity of the polarization vibration can enhance emissivity in 1 to 15 µm. The experimental results show that under a thermal treatment temperature of 1145°C, the emissivity of the sample can reach 0.9.

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PHYSICAL PROCESSES FOR MAINTAINING MEAN MERIDIONAL AND ZONAL CIRCULATION OF ATMOSPHERE IN MIDDLE LATITUDES (I)

[English abstract of article by Chen Qiushi [7115 4428 1102] of the Department of Geophysics, Beijing University]

[Text] The maintenance of mean meridional and zonal circulation is discussed by a splitting method with which the dynamic equations are split into two parts: the forcing effects and the thermal wind adjustment process. The forcing effects, such as the large-scale eddy fluxes, diabatic heating and friction, destroy the zonal thermal wind balance and the non-thermal wind can be returned to balance again in the adjustment process through the mean meridional circulation, from which the observed mean meridional cells are understood.

It is found that the vector form of the mean meridional circulation is approximately equal to a vector M, which is a combination of some forcing terms. Therefore, the mean meridional circulation can be directly deduced from the observational results of M. This conclusion is verified based on observational data.

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NUMERICAL SIMULATION OF GENERATION OF MESOSCALE CONVECTIVE SYSTEMS IN LARGE-SCALE ENVIRONMENT

[English abstract of article by Xia Daqing [1115 1129 1987], et al., of the Institute of Meteorological Research, Headquarters of the General Staff, PLA]

[Text] The generation of mesoscale convective systems is simulated by a seven-level primitive equation model. The large-scale part of the observed data at 1200 Z 11 June 1983, passing through a low-pass filter, is taken as the initial data. The results show that the generation of mesoscale convective systems can be simulated from fields of meteorological variables on the large-scale background. When the low-level southwest jet stream is very moist, mesoscale convective systems can develop ahead of the wind speed maximum in the warm sector of the Changjiang-Huaihe-River cyclone where the potential stability tends to remain negative. They are similar to the mesoscale convective complex (MCC), which appears frequently in the central part of the United States during the warm season (March to September), in the thermal structure, distribution of precipitation and process of generation and development.

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PHYSICAL PROCESS FOR MAINTENANCE OF MEAN MERIDIONAL AND ZONAL CIRCULATION OF ATMOSPHERE IN MIDDLE LATITUDES (II)

[English abstract of article by Chen Qiushi [7115 4428 1102], et al., of the Department of Geophysics, Beijing University]

[Text] The meridional eddy transfer of sensible beat is closely related to the transfer of the momentum in the large-scale quasi-geostrophic motion. The large-scale eddy transfers can be combined and then dissolved into two groups: a balanced transfer and an unbalanced transfer. The balanced transfer always causes the same value for the variations of the vertical shear of the mean zonal wind and the thermal wind in the temperature field. However, the unbalanced one always causes values with the same absolute magnitude, but with opposite signs for those variations.

It is argued that the unbalanced transfer, with which the transfer of the meridional circulations must be associated, plays a very important role in the maintenance of the mean zonal circulation and the zone of the subtropical anticyclones in the winter in the Northern Hemisphere.

The kinetic energy of the atmospheric motion is dissolved into a barotropic kinetic energy and a baroclinic kinetic energy, and the conversion processes of the energy are further discussed in detail.

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NUMERICAL SIMULATION OF MEDIUM SCALE DISTURBANCE ON MEIYU FRONT

[English abstract of article by Gao Kun [7559 0981], et al., of the Department of Geography, Hangzhou University]

[Text] Using a 10-level 90 km-mesh mesoscale numerical model, the authors have made a numerical simulation of a heavy rain during the meiyu season over the middle reaches of the Changjiang River. The model output is separated into synoptic and medium scale, with a selective filtering operator. The analysis lays emphasis on the characteristics of the medium scale disturbance linked with heavy rain and its synoptic scale environment. The authors suggest that the development of the medium scale disturbance and accompanying precipitation is due to an instability of the gravity inertial waves under certain synoptic scale conditions.

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STUDY OF PASSAGES OF CROSS-EQUATORIAL CURRENT DURING SOUTHERN MONSOON

[English abstract of article by Li Zengzhong [2621 2582 0022], et al., of the Academy of Meteorological Science, State Meteorological Administration]

[Text] In this paper, the authors have made a preliminary study of the passages of the cross-equatorial current at the lower and upper troposphere over the Indian Ocean and the northwest Pacific Ocean during the southern monsoon (from June to September). The grid wind and other data used in this study occurred from 1974 to 1979.

The average vertical velocity for every 5 days at 850, 700, 500, 300 and 200 hPa levels during June to August, 1979, has been calculated by means of the continuity equation. It is obvious that there are two monsoon cells of latitudinal circulation. The results are as follows:
1. The principal southern wind component passages at the lower troposphere over the equator of the eastern hemisphere are along (1) 45°E; (2) 105°E; (3) 150°E; (4) 70°E. The values of the southern wind component along these passages are larger than the average value of 0-180°E.
2. There are two main passages in which the currents cross over the equator from the Northern Hemisphere to the Southern Hemisphere at the 100 hPa level.
3. There are two closed latitudinal circulations which are obviously associated with the principal passages over the same region. One of them is located at the region between 45-70°E, while the other is near 100-105°E.

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INTERMITTENCY OF ATMOSPHERIC TURBULENCE--APPLICATION OF LYAPUNOV EXPONENTS AND FRACTIONAL DIMENSION

[English abstract of article by Shao Qingqiu [6730 1987 4428], et al., of the Department of Geophysics, Beijing University]

[Text] The atmospheric turbulence is highly nonuniform and intermittent. The characteristics of chaos are that positive characteristic exponents and fractional dimensions can quantitatively express the turbulent intermittency.

The variation of Lyapunov exponents with parameters can quantify the development of the state of a nonlinear system. The value of the fractional dimension D indicates the degree of intermittency, and the smaller the value of D, the stronger the turbulent intermittency.

The structure function law and energy spectrum law in homogeneous turbulence should be modified due to the intermittency. The intermittency also has powerful effects on the relative diffusion.

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ENVIRONMENTAL POLLUTION FROM AGRICULTURAL PESTICIDES EVALUATED

[Article by Yao Jianren [1202 1696 0088], Jiao Shuzhen [3542 3219 6297], and
Qian Yixin [6929 4135 2450] of the Chinese Academy of Agricultural Sciences,
Plant Protection Department, Lu Zhixin [4151 2784 2450] and Lin Mingzhen
[2651 2494 3791] of the Guangxi Academy of Agricultural Sciences, Plant Pro-
tection Department, Miao Lanzhong [5379 5695 0022] and Xu Jing [6079 2417] of
the Beijing Academy of Agricultural Sciences, Environmental Protection Research
Department, and Han Xilai [7281 5388 5490], Beijing Agricultural University,
Soil Chemistry Department. Received 31 March 1986]

[Excerpts] This study determines primary pollution sources and pollutants by
the method of calculated toxicity coefficients. Also, based on the amounts
absorbed in food and drinking water, it establishes weighting factors, and
thus calculates pollution indices for different agricultural areas in China.
Results indicate that the severely polluted areas are the grain- and cotton-
growing areas of the Chiang Jiang and the Huang He; furthermore, the BHC and
DDT pollution levels gradually decrease in the southerly and northerly direc-
tions.

In recent years, reports on the pesticide pollution situation in China's agri-
cultural environment have been numerous but, lacking objective, quantitative
methods, it has not been possible to accurately appraise agricultural environ-
mental quality. This paper represents a preliminary study of methods for
qualitative evaluation of pesticide pollution of the environment.

I. Basis of Qualitative Evaluation of Pesticide Pollution of the Environment

In China, crop varieties have noteworthy differences in keeping with climatic
zone variations. There is a close interrelationship among the amount of
pesticides used and the type and production level of crops. Thus, research
on the effect of pesticide pollution on environmental quality should first
consider the specific regional climatic characteristics and the relation
between the crop types and the action of the pesticide. To study and evaluate
the pesticide pollution [impact] on environmental quality this study selected
Guilin in Guangxi as representative of southern subtropical rice paddy areas,
Xinxiang in Henan as representative of grain and cotton producing areas of the

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central plains in the warm temperate zone, and Beijing as representative of the northern vegetable producing areas.

II. Methods for Environmental Quality Assessment of Pesticide Pollution

Established working procedures of the research objectives are shown in Figure 1.

1. Estimation of pesticide toxicity in China's agricultural environment

Today, over 100 kinds of pesticides are produced in China. In order to compare the danger level of each type of pesticide and the relation between the amount used and the residual amount, a "toxicity coefficient" is introduced which is a relative concept to indicate each source of pollution and the latent toxicity of a pollutant species with respect to the environment [2].

$$F_i = \frac{M_i}{D_i}$$

In this formula, F_i is the toxicity coefficient of pesticide i, M_i is the amount (kg/d) of pesticide i, and D_i is the assessment standard of pesticide i, the dosage amount of pesticide i (mg/kg) which, is lethal when ingested by white rats, times 55 kg (or the average adult human body weight).

According to calculations of the technical formula, Chinese organic chlorinated pesticides occupy 54-65 percent of the total toxicity coefficients and BHC occupies 51-60 percent of the total. Organic chlorinated pesticides are the main source of pollution in China's agricultural environment with BHC and DDT being the main pollutants.

2. Monitoring items

The pollution survey included organic chlorinated pesticides in regional soil, surface water, air, vegetables, fruit, grain, animal products (eggs, meat, etc.), and human bodies (fat, milk).

3. Monitoring network distribution points

According to agricultural crop types, monitoring network points were established in the Guangxi, Henan, and Beijing areas, three large areas of differing environmental conditions. The Henan network points were set up in the grain and cotton growing area of Xiaodian Village, Yanjin County, the main grain growing area of Liangcun Village, Hui County, and the main cotton growing area of Zhaojing Village, Huojia County. The Guangxi network distribution points were in the suburbs of Guilin municipality, Yangshuo, Lingchuan, and Xingan counties. Each village decided upon ten production teams for sampling the points. Except for data on human body fat, pork, and fruit which could be collected within the villages, and atmospheric data from the vicinity of the county weather station, all items were gathered from the aforementioned sampling points. The main vegetable- and fruit-producing areas of Beijing were sampled from evenly distributed points in the city. This increased the sampling points of the production areas of the gathered products.

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│        Survey of overall agricultural environment         │
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│ Determination of │ │ Determination of │ │ Monitoring network│
│ pollutant        │ │ monitoring items │ │ points           │
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│        Sampling, handling, and processing data            │
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│Atmospheric││Soil      ││Water     ││Fruit, vege-││Grain    ││Animal food│
│pollution ││pollution ││pollution ││table pollu-││pollution ││pollution │
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┌─────────────────────────────────────────────────────────┐
│ Determination of weighting parameter for each             │
│ environmental key factor                                  │
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│ Determination of math. model for comprehensive            │
│ assessment of environmental quality                       │
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│ Calculation of comprehensive pollution index for          │
│ each sample area                                          │
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│        Classification of pollution processes              │
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│ Definition of    │ │ Recognition of   │ │ Determination of │
│ main problems    │ │ changing patterns│ │ scope of pollution│
└──────────────────┘ └──────────────────┘ └──────────────────┘
         │                    │                    │
┌─────────────────────────────────────────────────────────┐
│  Specific measures to prevent pesticide pollution         │
└─────────────────────────────────────────────────────────┘
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Figure 1. Working procedure for environmental quality assessment
for agricultural pollution

4. Gathering, handling, and inspection of samples

The methods for gathering, handling and inspection of samples were carried out in accordance with agricultural department regulations. This research collected a total of more than 5,100 samples, and more than 41,000 pieces of data. The requirements for an environmental quality assessment for pesticide pollution were fundamentally satisfied.

III. Establishing an environmental quality assessment model

1. Selection of assessment standards

This work used national regulatory standards (GB-2715-81, GB-2763-81, GB-3097-82). The standards formulated in Reference 3 were used for soil, namely 0.3 ppm BHC and 0.5 ppm DDT. Based on the aforementioned standards, the following model (1) was used to calculate unit pollution indices; model (2) was used to calculate the unit pollution type indices[4]. Results are listed in Table 1.

$$P = \frac{C_i}{C_{si}} \tag{1}$$

$$P_i = \frac{1}{n} \sum_{i=1}^{n} \frac{C_i}{C_{si}} \tag{2}$$

In the formulas: P is the pollution index of pesticide i; P_i is the unit pollution type index; C_{si} is the assessment standard of pesticide i, namely, the health standard (ppm or ppb); C_i is the measured concentration (ppm or ppb); and n is the parameter item.

Table 1 shows that in the agricultural environment test points, the key environmental elements subjected to severe BHC and DDT pollution are soil and animal food products. The pollution level in animal food products far exceeds that in grain, fruit, and vegetables. This is because this type of pollutant is strongly fat soluble, can pass through the food chain and concentrate in animals.

2. Determination of weighting value

The introduction of pesticides into the human body can only be from food, drink, or inhalation. The amount of pesticide which enters the human body depends on the concentration and the amount absorbed by the key environmental factors. Thus, the principle of determining the weighting value of each key environmental factor is based on the daily, per capita required amounts of food, water, and air, multiplied by the corresponding allowable residual standard to determine all the harmful effects of a level of residual pesticide in a particular key environmental factor on the human body. In order to reflect objectively the actual amount of pesticide introduced into the human body by each key environmental factor, an evaluation method introducing a corrective parameter is used for the air and drinking water going through a

particular household. The corrective parameter for BHC in air is 0.01, and for DDT is 0.001; for BHC in drinking water, it is 10, and for DDT, it is 5. From the absorption rates of several crops, residual of several chlorinated pesticides in soil can be transformed to food content. Taking the average absorption rate of BHC as 0.39, and that of DDT as 0.06 for a crop, the amount of pesticide absorbed secondhand by the human body from the pesticide content of the soil is calculated[4-7]. Then we should reduce the crops in the soil absorbing sections (Table 2).

Table 1. Unit pollution indices of key environmental factors

Pesticide	Key factor Location	Grain	Fruit, vegetables	Animal food products	Soil	Atmo-sphere	Water
BHC	Huojia Cty.	0.058	0.135	1.052	0.674	2.000	0.132
	Hui Cty.	0.179	0.066	0.841	1.248	1.000	1.900
	Tingjin Cty.	0.204	0.078	0.974	0.567	1.000	2.120
	Average value	0.147	0.093	0.956	0.829	1.333	1.366
	Guilin	0.136	1.037	0.310	0.190	1.482	0.020
	Yangshuo	1.222	0.025	0.338	0.259	1.562	0.016
	Lingchuan	0.180	0.017	0.292	0.186	ND	0.023
	Xingan	0.132	0.017	0.440	0.498	1.561	0.026
	Average value	0.418	0.274	0.347	0.281	1.151	0.021
	Beijing	0.097	0.051	1.466	0.367	0.002	0.004
Total	Average value	0.221	0.139	0.930	0.492	0.829	0.470
DDT	Huojia Cty.	0.233	0.477	0.609	2.865	1.000	0.188
	Hui Cty.	0.664	0.123	0.320	2.127	0.160	ND
	Tingjin Cty.	0.321	0.370	0.659	1.246	ND	0.400
	Average value	0.406	0.323	0.526	2.079	0.367	0.196
	Guilin	0.064	0.537	0.120	0.069	0.223	0.026
	Yangshuo	0.053	0.069	0.120	0.346	1.536	0.006
	Lingchuan	0.146	0.066	0.189	0.095	ND	0.005
	Xingan	0.008	0.027	0.266	0.138	0.606	0.005
	Average value	0.068	0.185	0.176	0.162	0.691	0.011
	Beijing	0.128	0.129	0.543	0.320	0.001	0.0003
Total	Average value	0.201	0.212	0.415	0.854	0.320	0.069
BHC+DDT	Average value	0.211	0.176	0.672	0.673	0.574	0.269

Table 2. Daily amount of BHC and DDT absorbed by the body from key environmental factors

Pesti-cide	Amount absorbed (kg)		Allowable standard (ppm)	Correction parameter	Pesticide absorbed (mg)	Weighting value
BHC	Grain	0.533	0.3	Less crop absorbing portion	0.100	0.165
	Fruits, vegetables	0.500	0.2		0.100	0.165
	Animal food products	0.067	*1.0		0.067	0.111
	Atmosphere	7.2(m^3)	0.1(mg/m^3)	0.01	0.007	0.012
	Water	3(L)	**0.001(mg/L)	10	0.030	0.050
	Soil	(0.533)	0.3	Crop absorption rate	0.060	0.099
DDT	Grain	0.533	0.2	Less crop absorbing portion	0.092	0.162
	Fruits, vegetables	0.500	0.1		0.050	0.083
	Animal food products	0.067	1.0		0.067	0.111
	Atmosphere	7.2(m^3)	0.3(mg/m^3)	0.001	0.002	0.003
	Water	3(L)	0.001(mg/L)	5	0.015	0.025
	Soil	(0.533)	0.5	Crop absorption rate	0.016	0.026

* Average allowable standards for meat, eggs, fish, etc.
** Water quality standard for ocean water

3. Establishment of a comprehensive assessment model

Based on the unit pollution type indices and the weighting values of the key environmental factors, a comprehensive pollution index is calculated using a weighted summation method. The model is as follows:

$$PI = \sum_{i=1}^{n} W_i P_i \qquad \sum_{i=1}^{n} W_i = 1$$

In the formula: PI is the comprehensive pollution index; P_i is the unit pollution type index; W_i is the assessment parameter weight; and n is the number of assessment parameter items.

The data from Table 1 were treated using the above model with results listed in Table 3. For the Xinxiang, Hunan area, PI = 0.524; for the Beijing area; PI = 0.326; for the Guilin, Guangxi area, PI = 0.242. Depending on the size of the PI value, the pesticide pollution process of a test point area can be placed in one of five levels.

Table 3. Pesticide pollution levels in the agricultural environment

Level	Comprehensive pollution index	Area limits
Clean	<0.250	Guilin, Guangxi
Very low pollution	0.250-0.350	Beijing area
Light pollution	0.350-0.450	
Medium pollution	0.450-0.550	Xinxiang, Henan
Heavy pollution	>0.550	

The residual BHC and DDT condition of the key environmental factors in certain areas no doubt is related to the amount of pesticide used, but the purification effects of the environment have a more important effect. Previously, it was flet that 3 to 11 years were required to clear up 95 percent of the BHC in soil[1]. Now, it is considered that, with flood water and high temperature conditions, it will clear up within a few weeks. Thus, although BHC and DDT decreases in terms of amount used per unit area from south to north, however, the trend of BHC and DDT pollution in China's agricultural environment is clearly characteristic of geography; moreover, this type of geographical characteristic is closely interrelated with climatic zones[8]. If the Guilin, Guangxi area is taken as representative of the subtropical area, the Xinxiang, Henan area taken as representative of the central plains warm temperate zone, and Beijing taken as representative of the northern temperate zone, then the BHC and DDT pollution of China's agricultural environment should peak in the Chang Jiang and Huang He basins and gradually diminish in the northerly and southerly directions. The light pollution in the south is due to the strong purification effect; the light pollution in the north is due to the small amount used per unit area; the severe pollution in the central plains areas is because the amount used is greater than that in the north and also because the purification effect is weaker.

IV. Control measures

1. Recommendations concerning the utilization of chlorinated organic pesticide reserves

Production of BHC and DDT has already ceased in China; today, the country still has a certain amount of reserves; with no further addition to the reserves and continuing their use under normal conditions, these could be used for at least 2 to 3 years. We recommend that the use of these pesticides be stopped in the central plains areas (severely polluted areas), and that their use in grain [preservation] be absolutely prohibited. The pesticide reserves may be offered for sale in the south where there is a strong purification effect (Yunnan, Guizhou, Fujian, etc.); they may also be used in areas in the north (Qinghai, Gansu, Ningxia, etc.) where the pollution index is relatively low.

2. Control of severely polluted areas

In severely polluted areas where BHC and DDT are no longer used, the main causes of food pollution are crops which absorb residual pesticide from the soil. There are two control measures:

(1) Accelerating the clearing up of residual BHC and DDT in the soil. The most effective method is to create flood water conditions and increase the compost leading to microorganism communities which can degrade BHC (for example, Achrobacterium, Alcaligenes, Bacillus polymyxa, Bacillus macerans, Bacillus brevis, Bacillus laterosporus, Bacillus coli, Clostridium butyricum, etc.) and the microorganism communities which can degrade DDT (for example, Achromobacter, Agrobacterium, Bacillus, Clostridium, Erwinia, Escherichia coli, Hydrogenomonas, Methanococcus, Mucor, Fusarium, etc.).

(2) Regarding the absorption of BHC and DDT, there are two measures for crop control. One is to lower the pesticide concentration in the soil (following the example from abroad of cultivation with decreased soil pesticide concentration)[7]. But the most important and most convenient measure is to prohibit crop types with high absorption efficiency from severely polluted fields (carrots and other edible tubers and oil crops, such as peanuts and soybeans). We should change to planting sorghum and starchy crops or industrial crops.

V. Problems and discussion

The environment is a dynamic system; within this system, the absorption of pesticides has an intrinsic moving locus, the food chain being its indicator. Thus, the most important object in determining a weighting coefficient is the degree of harm to humans from the average residual pesticide in each key environmental factor. But because there are several key environmental factors for which China is temporarily not formulating allowable health standards, and, also, there are residual pesticides in key environmental factors for which there is no direct relationship with the human body, therefore, a correction parameter for each key environmental element should be introduced to perfect the weighting coefficient.

1. Correction parameter for air and water

China usually does not dictate allowable health standards for BHC and DDT in the air but just borrows on the air health standards of automobiles (0.1 mg/m^3 for BHC and 0.3 mg/m^3 for DDT). If it is estimated that each person inhales 12 m^3 of air each day, then an amount of 1.2 mg of BHC and 3.6 mg of DDT enters the body from the atmosphere. The amount of BHC is 4 times, and the amount of DDT is 10 times, the amount absorbed into the human body from plants and animal food products; this is clearly inconsistent with objective reality. After consultation with relevant specialists, it is considered very appropriate to introduce a correction parameter of 0.01 for BHC and 0.001 for DDT. Drinking water is also lacking a health standard for chlorinated organic pesticides and just borrows from the permissible health standards for ocean water (GB-3097-82), that is 0.001 mg/L. If it is estimated that each person drinks

3 liters of water each day, then 0.003 mg of BHC and DDT enters the body from drinking water. This amount appears to be low and for this reason a correction parameter of 10 for BHC and 5 for DDT is introduced. According to reports[9], of the amount of chlorinated organic pesticides stored in the human body, about 90 percent is from food, about 6 percent is from drinking water, and 1 percent is from the air. Estimates from corrected parameters are 91.4 percent from food, 7.2 percent from drinking water, and 1.4 percent inhalation. These results agree with the referenced reports.

2. Soil correction parameters

Residual pesticide in soil can result from absorptive transfer from other locations. The pesticide absorption rate of crops not only depends on the quality of the pesticides themselves and the types of crops, but also depends on the concentration of the residual pesticide in the soil and the growing season of the crop. Current methods for estimating the rate of crop absorption do not agree and an accurate expression of crop absorption efficiency is difficult[10]. Here, based on 7 crop types for BHC and 4 crop types for DDT, and two estimation methods, the estimating equation for the average crop absorption rate is

$$\bar{\bar{X}} = \frac{\sum_{i=1}^{m} \bar{X}_i}{m}$$

The results give a crop absorption rate of 0.39 for BHC and 0.06 for DDT. Thus, for the situation of residual BHC and DDT in soil transformed from the pesticide content in grain, a direct connection is established between the soil environment and the human body in this way. Because soil effects exist as an independent unit key factor for an assessment model, the fraction of absorbing crops should be subtracted by considering the daily, per capita amount of pesticide brought into the food. Strictly speaking, fruit trees, vegetables, and the like, can absorb residual pesticide from the soil, but except for specific types (for example, carrots, etc.) whose absorption rate is very high, the numerous other types have very low absorption rates. Residual pesticide which volatilizes from the soil can enter the atmosphere or permeate and pollute ground water, and should be handled with a similar transformation as used for crop absorption, but because the latter type of transport involves minute quantities, they were not considered in this work.

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13226/7358

STUDY OF CONVERSION OF SULFUR FROM BURNING COAL

[Text] SO_2 is one of the major pollutants in the air. The extent of SO_2 pollution is related to the SO_2 emissions from coal burning boilers. A method for calculating the SO_2 emissions from boilers within a large area poses significant problems. This paper describes the mechanism of sulfur conversion in coal. According to the method of sulfur balance and a large amount of testing data, the rate of SO_2 emission and the factor of SO_2 conversion from burning coal can be obtained. Based on this, the authors can accurately and conveniently calculate the SO_2 emissions from coal burning boilers in cities or urban areas during different periods.

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IMMUNO-HISTOCHEMICAL STUDY OF EXPERIMENTAL EPIDEMIC HEMORRHAGIC FEVER

[English abstract of article by Zhu Yingeng [2612 5593 5087], et al., of the
China Pharmaceutical and Biological Product Verification Office]

[Text] Suckling Meriones unguiculatuses were inoculated via the IP, IC or SC
route with Hantaan or R3 strain HFRS virus suspension. One or two animals
were killed at a 2-3 day interval following inoculation for a total period of
1 month. The results are as follows:
1. Following IP or IC infection with the Hantaan or R3 strains, the suckling
animals died within 2-4 weeks. HE sections showed various extents of inter-
stitial pneumonia and encephalomyelitis. Positive immunoenzymatic viral
antigens were first detected in the lungs, followed by the brain and other
organs.
2. Lesions of the lungs and other organs, execpt the brain, in animals
inoculated with the R3 strain were milder than those of the Hataan animals,
but the R3 strain, similar to the Hataan virus, showed an active affinity
with the brain.
3. The suckling Meriones unguiculatus was more sensitive to the HFRS virus
than was the suckling mouse, and is considered to be the choice for use in
an experiment to identify the virulence of different HFRS strains.

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ADCC EFFECT MEDIATED BY McAb AGAINST JEV

[English abstract of article by Zhang Mingjie [1728 2494 2638], et al., of the Department of Microbiology, Fourth Military Medical College, Xi'an]

[Text] Using mice spleen cells as effect cells and JEV-infected BHK21 cells as target cells, the ADCC effect mediated by six JEV-McAbs was measured. Results revealed that the species and genus specific McAb ($2H_4$, $2F_2$, nG_2 and mG_9) did not mediate the ^{51}Cr releasing activities. Two subgroup McAbs, mC_3 and $2D_2$, possessed the ADCC effect but differed. There was no relevance between ADCC activities and HI or NT functions. The ADCC activity of mice spleen cells subsided gradually after JEV infection which may be related to the pathogenic effect of JEV. The ADCC effect may impose certain protective effects on JEV infection.

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STUDY OF PLASMID CODING FOR ENTEROTOXIN. 4. CHARACTERIZATION AND DETECTION OF COLONIZATION FACTOR ANTIGEN I AND II (CFA/I AND CFA/II) IN ENTEROTOXIGENIC ESCHERICHIA COLI ISOLATED FROM HUMANS

[English abstract of article by Yao Ruijin [1202 3843 6855], et al., of the Department of Microbiology, Fujian Medical College, Fuzhou]

[Text] Colonization factor antigens I and II (CFA/I and CFA/II) play an important role in the pathogenesis of diarrhea due to enterotoxigenic Escher Escherichia coli. In this study, ETEC strains isolated from 130 persons with diarrhea and E. coli strains isolated from 269 healthy neonates were examined for the presence of CFA/I and CFA/II, using mannose-resistant hemagglutination, salt aggregation, bacterial agglutination with CFA/I and CFA/II antisera, indirect fluorescent microscopy, electron microscopy and immune electron microscopy. CFA/I and CFA/II were identified in 13 of 34 strains (38 percent) with heat-labile and heat-stable enterotoxins (LT^+/ST^+), but in only 4 of 35 LT^-/ST^+ strains (11 percent, $P < 0.01$) and 5 of 61 LT^+/ST^- strains (8 percent, $P < 0.01$). CFA/I and CFA/II were not found among the 269 non-ETEC strains. The ETEC strains bearing a CFA/I and CFA/II had the following properties: 1) showed $MRHA_{hum}$ or $MRHA_{bov}$; 2) the lowest $(NH_4)_2SO_4$ concentration causing bacterial aggregation was 0.2 molarity; 3) electron micrographs of bacteria showing CFA/I or CFA/II fimbriae on their surface and CFA/I or CFA/II antiserum was absorbed to the surface associated filaments.

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PLASMID MOBILIZING OF SHIGELLA SONNEI FORM I ANTIGEN--CONSTRUCTION OF BIVALENT ANTIGEN STRAIN

[English abstract of article by Wang Weiyuan [3769 5633 1254], et al., of the National Institute for Control of Pharmaceutical and Biological Products, Beijing; Bao Youdi [0545 1635 6611] of the Department of Microbiology, Fujian Medical College]

[Text] Shigella Sonnei, an intentinal pathogen, produces a characteristic form I cell surface antigen which is encoded by a large nonconjugative plasmid. Using a plasmid mobilizing system, the authors were able to transfer the form I antigen-synthesizing genes to S. typhimurium, thereby obtaining a bivalent antigen strain. Serological studies reveal that the derivative strain produces both antigens--the form I antigen and the S. typhimurium somatic antigen. This paper describes the construction and preliminary characterization of this derivative strain.

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PRELIMINARY REPORT ON ANTIGENIC VARIATION OF TYPE III POLIOVIRUS USING
NEUTRALIZING McAb

[English abstract of article by Tang Enhua [0781 1869 5478], et al., of the
Institute of Medical Biology, Chinese Academy of Medical Sciences, Kunming]

[Text] Antigenic properties of 91 strains of type III poliovirus were tested
with 8 McAb and classified into 10 groups accordingly. The P3-4 group,
about 49.5 percent of the tested strains, may comprise the current epidemic
group. The Finland/02575/84 strain, which caused the 1984 type III epidemic
in Finland, and Yunnan/7/84 isolated during the 1984 epidemic in Yunnan,
china, both belong to this group. Their antigenic characteristics are
different from those of the Sabin type III strain or reference virulent
strain.

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SELECTIVE CYTOTOXICITY OF ANTI-CEA McAb-DT(A) IMMUNOTOXIN FOR HUMAN STOMACH
CARCINOMA CELL LINE

[English abstract of article by Ji Hong [4764 4767], et al., of the National
Vaccine and Serum Institute, Beijing]

[Text] The immunotoxin was prepared by conjugating the A chain of diphtheria
toxin [DT(A)] with anti-CEA McAb. The immunotoxin showed cytotoxicity for
human stomach carcinoma cell line KATO III, which was CEA positive, but no
cytotoxicity for CEA-negative Hep-2 and Hela cell lines. The cytotoxicity of
the immunotoxin was much higher than the mixture of anti-CEA McAb and DT(A).
The diphtheria antitoxin in the concentration of 0.064 IU/ml was able to
neutralize the effects of the anti-CEA McAb-DT(A) immunotoxin.

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MODULATION OF MACROPHAGE-MEDIATED CYTOTOXIC ACTIVITY. 4. EFFECT OF MYCOTOXIN T-2 ON MACROPHAGE ACTIVATION BY MAF

[English abstract of article by Dong Zhongyun [5516 6988 0061], et al., of the Department of Immunology, Cancer Institute, Chinese Academy of Medical Sciences, Beijing]

[Text] The effects of treatment with T-2 toxin in vitro on macrophage-mediated cytotoxic activity have been investigated. Both macrophage-mediated tumor cell lysis (MTC) and antibody-dependent cellular cytotoxicity (ADCC) were assayed. The results indicate that the T-2 toxin by itself has no influence on the macrophage function in either assay. When macrophages were treated with the T-2 toxin at the same time as a macrophage-activating factor (MAF), however, the T-2 toxin significantly enhanced the activating effect of the MAF. The T-2 toxin seems to have no effect on the susceptibility of tumor target cells to macrophage-mediated lysis.

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PRODUCTION OF MONOCLONAL ANTIBODY COC 166-9 AGAINST HUMAN OVARIAN TUMOR ASSOCIATED ANTIGENS

[English abstract of article by Qian Henian [6929 0735 1628], et al., of the Gynecological Cancer Research Laboratory, Department of Obstetrics and Gynecology, People's Hospital]

[Text] Three cloned hybridoma cell lines were obtained by fusion of murine myeloma cells with spleen lymphocytes from BALB/c mice immunized with soluble antigens prepared from two ovarian serous papillary adenocarcinomas. One of the three cell lines proved to be antibody-producing after storage for over 4 months, and was named MAb COC 166-9. The chromosome count was 95 and the subclass was identified as IgG_1. No cross reactions with A or B red cell grouping substances, HLA, CEA or αFP , were observed. The selected COC 166-9 clone was positively stained against eight ovarian epithelial carcinomas by indirect immunofluorescence. Carcinomas of the lung and breast, benign ovarian tumors and myeloma of the uterus as well as normal ovaries were all negatively stained, except for one case of carcinoma of the rectum. Therefore, the use of COC 166-9 may have a bright future in the diagnosis of ovarian epithelial carcinomas.

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STUDY OF MONOCLONAL ANTIBODY PC6 AGAINST GASTRIC CANCER

[English abstract of article by Dong Zhiwei [5516 1807 0251], et al., of
Beijing Institute for Cancer Research]

[Text] Spleen cells from Balb/C mice immunized with gastric cancer cell line
MGC803 were fused with murine myeloma cell line NS-1. A hybridoma PC6 was
obtained which secreted the monoclonal antibody (McAb) against gastric cancer.
McAb PC6 reacted positively with 2/4 gastric cancer cell lines and 14/25 tis-
sues of gastric cancer. It also cross reacted with lung and ovary cancer cell
lines, but did not react with other tested normal and tumor cells or embryonic
or adult normal tissues. It was shown that McAb PC6 had good selectivity.
The corresponding McAb PC6 antigen was located on the target cell membranes
in vitro, and could be found in the membrane and cytoplasm of gastric cancer
tissues. Preliminary work showed that the antigen is resistant to heating
and trypsin treatment, but sensitive to pronase treatment and, therefore, it
might be a glycoprotein or proteoglycan.

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HEMODYNAMIC AND RENAL EFFECTS OF HUMAN ALPHA ATRIAL NATRIURETIC PEPTIDE (α-HANP) IN SIX PATIENTS WITH CONGESTIVE HEART FAILURE

[English abstract of article by Xu Chengbin [1776 2052 2430], et al., of the Department of Cardiology, People's Hospital]

[Text] The hemodynamic and renal effects of α-HANP in six patients with congestive heart failure of various causes were studied. Each patient was given 400 µg of α-HANP either intravenously or by a Swan-Ganz catheter. The cardiac output was measured by the thermodilution method, and the other hemodynamic parameters were measured by the Swan-Ganz catheter.

The results showed: (1) a significant increase in the cardiac output and cardian index; (2) a depressing effect of cardiac pressure in three of four cases, and a depressing effect of systemic and pulmonary vascular resistance in most cases; (3) a moderate increase in urine volume and sodium excretion, and a variable excretion of potassium; (4) a slight decrease in blood pressure, heart rate and respiration rate; (5) significant improvement in the symptoms and signs of congestive heart failure; (6) a significant decrease in ventricular ectopic beats in two cases. No significant change in the systolic time interval was found and no significant side effects were observed.

The results, which were quite different from those found in animals and volunteers, are discussed.

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STATE COUNCIL APPROVES STEPS TO ENCOURAGE TECHNOLOGY EXPORTS

40080014 Beijing KEJI RIBAO in Chinese 22 Sep 87 p 2

[Text] In order to encourage technology exports, the General Office of the State Council has recently given approval to temporary steps by the Ministry of Foreign Economic Relations and Trade and the State Science and Technology Commission to encourage technology exports. The main provisions are:

1. Technology exports constitute part of China's foreign trade, are one way to generate foreign exchange, and have an increasingly important role. Technology exports must be given preference in terms of retention of foreign exchange, taxation, credit, and capital.

2. Technology exports refer to companies, enterprises, groups, or individuals within the borders of the PRC.

3. Foreign exchange retention and use will be in keeping with regulations: In the case of software exports, 35 percent of the foreign exchange earned will be passed on to the state, with 65 percent being retained. Of the aforementioned 65 percent, 7 percent will go to the technology exporting unit, 15 percent will go to the export management company, and 15 percent will be given to local or central management departments in keeping with the subordination/affiliation relationship involved.

4. In the case where software exports lead to hardware exports, the cost in terms of foreign exchange of the hardware portion shall be handled in keeping with exports of goods in the same category.

5. Income from software exports by state-run enterprises will be temporarily tax exempt for the two year period between 1 July 1987 and 30 June 1989, and the question of taxes on income from software exports will be handled in keeping with relevant state regulations. In the case of software or hardware exports by collective enterprises or individuals, the income tax question will be handled in keeping with relevant state regulations.

6. Electromechanical goods exported along with technology exports will, in keeping with regulations, enjoy the special interest-deducted loans and sellers credit [stipulated by] the state to support and encourage export of electromechanical goods.

7. Relevant central and local departments and enterprises should all provide active support for the export of electromechanical product parts and components, spare parts, and raw material for [such] production resulting from the export of software. As for the export of required raw materials and fittings, this shall guaranteed priority as stipulated in state document 128 (1985). This procedure shall be in effect starting 6 August 1987.

/9274

ESTABLISHMENT OF 42 KEY NATIONAL LABORATORIES DISCUSSED

40082110b Beijing GUANGMING RIBAO in Chinese 3 Apr 87 p 1

[Article by Ye Weiqiang [0673 4850 1730]: "China Is Establishing or Has Established 42 National Key Laboratories"]

[Text] Key national laboratories which were started at the time of the reform of science and technology and education have now entered the steady construction stage. According to disclosures at the National Key Laboratory Construction Work Conference which concluded on 2 April, during the Sixth 5-Year Plan, China built 20 national key laboratories, and construction has begun on another 22 of the 50 national key laboratories planned for construction during the Seventh 5-Year Plan. Up to the end of last year, China had cumulatively appropriated 98 million yuan for this construction.

In order to concentrate resources and establish a group of laboratory bases representative of China's level of scientific research, since 1984 China has built national key laboratories in a planned way. Four laboratories have now undergone appraisal and been released for service, and it is estimated that by the end of 1987, 20 laboratories will be released. After the 70 national key laboratories planned for construction during the Sixth and Seventh 5-Year Plans are built and released for service, it is hoped to gather 2,000-3,000 science and technology personnel to work in them, to form a science and technology echelon of a high level, capable, and with special characteristics.

At the key laboratory work conference convened by the State Planning Commission in Beijing, participants from various localities exchanged construction experience. At the meeting, Chen Jiaer [7115 0163 3167], vice president of Beijing University, described the scientific research and technical corps put together by Beijing University for the state, the ways of creating working and living conditions and relevant ideas for national key laboratories. Zhang Shou [1728 1108], deputy chairman of the State Planning Commission, gave a speech at the meeting in which he expressed hope that key national laboratories would realize a system in which there is a joint and unrestricted sharing—i.e., realize sharing of instruments and equipment, mobility of talent, exchange of learning and overlapping and permeation of science in order to rapidly establish a high-level research corps that will concentrate on some key technological issues which will have an effect on the national economy in tackling various projects for the nation.

8226/9835

PROPOSAL TO ESTABLISH ENVIRONMENTAL ECONOMIC INDICATOR SYSTEM IN CHINA

[English abstract of article by Chen Youxiang [7115 3731 5046], et al., of
the Jiangsu Provincial EPA, Nanjing; Li Kang [2621 1660], et al., of the
Chinese Research Academy of Environmental Sciences, Beijing]

[Text] This paper explains briefly that the environmental economic indicator
system is a powerful tool for integrating environmental protection with
national economic and social development planning and for conducting a
comprehensive balance of the national economy in consideration of environmental
factors. The authors present the concept of employing environmental loss,
environmental investment and the benefits of environmental investment as
essential elements in establishing the environmental economic indicator system
which would describe the relationships among the economic system, the social
system and the environmental system by means of uniformly quantitative economic
information. Therefore, the interaction mechanism of the three systems can
be understood and their control or adjustment will be possible. The structure
and classification of the indicator system, the calculation method and research
procedures for perfecting the indicator system are also presented in this
paper.

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PROVINCE-LEVEL INSPECTION OF S&T RESULTS PROPOSED

40082110f Beijing GUANGMING RIBAO in Chinese 31 Mar 87 p 2

[Article by Lin Ziyang [2651 1311 2799], deputy secretary of the Hunan Province Microbiology Society: "To Guarantee the Autoritative Nature and Quality of Science and Technology Results Inspection and To Save Both Manpower and Financial Resources As well As To Enrich Scholarly Activity; Proposal for Provincial Level Disciplinary Societies To Undertake Inspection of Science and Technology Results"]

[Text] Currently, there are many abuses in regard to inspection of science and technology results, whether in convening an inspection meeting or in a written inspection by a specialist from a relevant unit on the basis of materials on an inspected science and technology result, and these can be summarized as follows:

1. Personal relationships. The representatives invited from inspection societies or relevant specialists who request that materials be sent for inspection are suggested by the unit that receives the inspected science and technology results, and thus the subjective factor of expecting that the result will pass inspection is unavoidable. This frequently means that the representative's relationship is that of a mentor, a fellow student, a fellow countryman or a good friend, so that the old teacher is concerned about the student, the student respects the teacher, the famous teacher has a highly placed disciple, and there is the tendency for mutual respect; thus, it is difficult to avoid a chorus of cheers without seeking the truth from facts with regard to the results.

2. Materials relationships. This is primarily manifested in increasingly larger expenditures for science and technology results inspection meetings and the giving of larger and larger presents. A few years ago the best souvenir of a science and technology results inspection meeting was a commemorative photograph of all the representatives or an invitation to the representatives to see a motion picture. But now science and technology results inspection meetings frequently result in a tour of the famous sites and the giving of presents, and the gifts are of all types, from as small as a table lamp to as large as a woolen blanket or even cash. Needless to say the representatives stay in good hotels, eat well, and enjoy themselves, with the units outdoing each other and the scale higher and the expenditures greater each time. The goal is simply for the representatives to say good

things about the results and sing their praises, and the representatives generally can readily take the hint and pander to this desire.

3. Subordinate relationships. The representatives invited are from units below the level of the unit which has obtained the results, or plant (site), hospital or use unit which has received some support for part of its expenses by the results unit, or a small unit in the same field. The participation of these representatives in the inspection meeting frequently amounts to no more than giving praise. Some units invite an authority to attend an inspection meeting, and whatever the authority says, the other representatives can only concur, and if they have opinions they cannot express them.

Because of these abuses, the result is that only good things are said and the benefits of the result are exaggerated, even to the point of spoiling things by excessive exaggeration, so that the benefits of the science and technology result being inspected cannot be accurately evaluated. In places where the results are inadequate, in particular, even the errors cannot be pointed out for correction, so that when the result is promoted for use it does not meet the inspection standards and it must be halted, which causes severe loss to society. For this reason, inspection work on science and technology results urgently needs to be reformed. This writer believes that it would be beneficial for provincial level discipline societies to undertake the work of inspection of science and technology results so as to guarantee the quality of science and technology results; save on the manpower, material and financial resources of inspection work; and enrich the activity of the societies. The specific reasons are:

1. It is more authoritative for societies to undertake science and technology results inspection. Societies not only are the home of scientists and technological workers, with the advantages of concentration of intellect and galaxy of talent, but also are fields where domestic and international scholarly exchanges are carried out; their members master a large amount of domestic and foreign science and technology information quickly and accurately, and they are the agencies that have the scholarly authority. Naturally, in terms of appraising the scientific, economic and social benefits of science and technology results, societies are authoritative agencies and are dutybound.

2. For societies to undertake science and technology results inspection will guarantee the quality of the inspection result organizationally. This is because: (1) Societies can, according to the results of the inspection, propose representatives to participate in the inspection meeting from among their members or send a list of inspectors, thus proceeding from an objective position and avoid the interference of artificial factors. (2) They can avoid being subjected to the influence of emotional viewpoints. After completing the results report or submitting materials, those who receive the inspection results can avoid another inspection. In this way those in charge are not on the scene and visitors can speak freely. (3) Since they should be prepared to answer questions from those who obtain the inspection results, in the results inspection process societies should support the authority of the society and thus maintain a high sense of responsibility with regard to the results of the inspection.

3. For societies to undertake science and technology results inspection will
save manpower and financial resources. If societies organize science and
technology results inspection, they can avoid the creation of irregular
personal relationships; they can ask representatives from among neighboring
societies to participate, and this will not require asking teachers or country-
men or good friends from further away, saving the province a great deal in
travel expenses, also, the society members will not have to stay in hotels,
thus saving the province high lodging expenses. At the same time, if science
and technology results inspection is made part of the society's work, it
will become the task of the society and will not require the unit to enter-
tain or provide gifts, as would be the custom with guests, thus saving
expenses for food and avoiding expenses for gifts. The representatives can
leave early and return late, without requiring the 4 or 5 days ordinarily
involved, and thus economize on manpower, material, financial resources and
time; if written inspection is conducted on science and technology results
materials that are sent, then it can save in many areas and greatly reduce
expenditures.

4. For societies to undertake inspection of science and technology results
will greatly enrich the scholarly activity of the society. The primary task
of societies is to encourage scientists and scientific workers to engage in
scholarly activity at home and abroad and to conduct scholarly exchanges.
This writer believes that science and technology results inspection meetings
that include creative, advanced and practical science and technology results
constitute scholarly exchange activity. According to statistics, each year
China has inspection meetings on thousands of science and technology results,
and if we can include them in the work of societies, then it will greatly
enrich the activity of the societies. This not only will help the societies
to conduct their scholarly activity on the basis of reality and improve the
quality of scholarly activity, but will also give society members a greater
sense of responsibility, spurring the inspection of documents and the finding
of evidence. In this way, the implementation of numerous science and technology
inspections at many levels can improve the scholarly level of the society
overall and thus further guarantee the quality of results inspection and
spur the society to constantly work to achieve a high level.

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S&T INTENSE DEVELOPMENT AREA ESTABLISHED IN CHENGDU

40082110e Beijing GUANGMING RIBAO in Chinese 31 Mar 87 p 2

[Article by Wang Zhe [3076 0772]: "Taking Advantage of the Superiority of Each for Comprehensive Benefits; Chengdu S&T Commission, Science and Technology University and Shuangliuxian Jointly Establish an S&T Intense Area"]

[Text] The foundation work for the Shuangliu Science and Technology Intense Development Area--a Changdu municipal science and technology intense area jointly established by the Chengdu Municipal Science and Technology Commission, Chengdu Science and Technology University and Shuangliuxian--is now well underway.

At Chengdu city's institutions of higher learning and research institutes, a galaxy of science and technology talent is concentrated; the number of science and technology cadres in all specializations exceeds 200,000; more than 660 out of every 10,000 staff members and workers are science and technology personnel; and it is at the head of 18 large cities nationwide. All this creates favorable conditions for the Chengdu area to establish a science and technology intense development area. Chengdu Science and Technology University is a comprehensive university that focuses primarily on engineering; science and engineering are combined, with a permeation of humanities and science, and abundant intellectual resources are present. The environment of Shuangliuxian, which is situated in Chengdu's suburbs, is ideal, and in recent years in particular its economic development has been rapid, so it has a certain material foundation. Under the guidance of the Chengdu Municipal Science and Technology Commission, the necessary concept of a general plan suited to Chengdu area's science and technology and socio-economic development took shape, and in January of this year the three parties formally signed an agreement to establish a Chengdu science and technology intense development area--the Shuangliu Area.

The general goal of establishing the Shuangliu Science and Technology Intense Development Area is, as the agricultural economy grows, to absorb the excess agricultural population through the advancement of science and technology so that the development of Shuangliuxian will match that of Chengdu's central city and by stages will extend to the suburban areas the science and technology results of the central city.

The agreement clearly stipulates the rights and obligations of all parties: Shuangliuxian is to provide the material resources, land, and manpower; Chengdu Science and Technology University primarily is to provide the intellectual resources, supplying the results of advanced technology to Shuangliuxian on a priority basis; and the Municipal Science and Technology Commission is responsible for coordination. The Municipal Science and Technology Commission, Chengdu Science and Technology University, and Shuangliuxian established development funds at the investment ratio of 2:1:7, with a total amount of 1 million yuan to be used for area development research.

At present, basic work has begun. In an on-the-spot survey, Chengdu Science and Technology University considered the current market situation and provided the first group of 10 quick-result projects to Shuangliuxian for development, with the aim of increasing the xian's economic strength. For example, the research results provided first--a power grid dispatching terminal and dispatching terminal equipment--is the equipment necessary for implementing medium- and small-scale power grid automation; one set can earn 90,000 yuan in profits, reform nine sets of equipment needed by power plants, and can be promoted for use in over 100 power plants nationwide. This year it might earn considerable economic benefits. To set up the training for area talent, the Chengdu Science and Technology University has established the Shuangliu Training Section at Shuangliuxian and has taken responsibility for instruction. On this basis specialized classes will be offered to train the talent urgently needed for establishing the area.

After it has a certain amount of economic strength and technical talent, Shuangliu Area construction will move in the direction of intensive high technology. Currently, the Chengdu Science and Technology University is conducting research on two soft science projects: research on Shuangliu Science and Technology Intense Development Area planning and research on policy and management of the Shuangliu Area. When these two projects are completed, an overall plan for the development of Shuangliu Area will be formulated so as to combine the area's education, research and economic development.

Officials of the Chengdu Municipal Science and Technology Commission said: Through reform and experiment in the process of national science and technology advance and economic development, we want to seek out a path of establishing a science and technology intense region which is primarily self-reliant.

8226/9835

DEVELOPMENT ORIENTATION OF RESEARCH INSTITUTES' PILOT PLANTS

40080102 Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENCE OF SCIENCE AND MANAGEMENT OF S&T] in Chinese No 4, Apr 87, pp 8-9

[Article by Chen Suwei [7115 4790 4850] of the Ministry of Metallurgical Industry: "A Discussion of the Development Orientation of Scientific Research Institutes' Pilot Plants"]

[Text] The basic goal of reforms in S&T systems is to utilize S&T achievements quickly and broadly in production. The solution to this question is not a simple one, however, from the perspective of intermediate testing plants, which are responsible for the trial development and materialization of S&T achievements in the form of knowledge made by scientific research units, there are many questions concerning the new situation during reforms of these systems. What should be their orientation? Can they continue to exist? These are questions of principle that are linked directly to the ability to utilize S&T achievements in production. The author starts with the actual situation to explore the development orientation of such plants as well as their responsibilities and the conditions of their existence and growth to permit intensive discussion of this question as soon as possible.

I. Changing Forms, Changing Orientations and Vitality

During the current reforms in S&T systems, the question of how to use S&T achievements quickly in production to serve society and to serve producing enterprises is the development orientation of scientific research institutes as well as the development orientation of pilot plants. Still, the fact that plants must progress along this direction remains an unsolved issue for most people at the present time. The reason is that administrative departments at higher levels formerly established pilot plants in scientific research units and told them to "serve scientific research." This traditional view was formed over many years, and it will not be easy to change everyone quickly. However, issues regarding the developmental orientation of pilot plants must be solved and they should adapt to the developmental needs of the new situation. There must be a fundamental transformation in strategic ideology and plants should work actively to shift their orientation to production and economic construction by changing forms and orientations. This is the basic issue concerning the plants during reforms in S&T systems, and it also is the source of vitality and life in the plants. It should be pointed out that if pilot plants are to progress in this direction, there must be a clear solution to their status in the process of utilizing S&T achievements in production as

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well as the tasks for which they are responsible. This is in essence a concrete manifestation of their orientation toward production and economic construction.

II. The Bridge from Scientific Research to Production

Pilot plants in scientific research units are a horizontal channel of direct linkage between scientific research and production, and the plants are central links in the diverse relationships between them. More precisely, they are a bridge between scientific research and production. In scientific research units which focus mainly on applied scientific research, their scientific research achievements continue to occur in the form of knowledge, regardless of the institute. They are latent, indirect forces of production, and they must undergo a process of materialization before becoming direct forces of production, and they must undergo a process of materialization before becoming direct forces of production. Data from China and other countries indicate that the process from scientific research to production can be divided into seven stages, as shown in the following chart:

Figure: Illustration of the Scientific Research--Production Process

Basic theoretical research	New product feasibility studies	Applied Research	New product design	Intermediate testing (small scale, expansion	Semi-industrial production
Social needs	Improvement				Industrial Production
					Social product
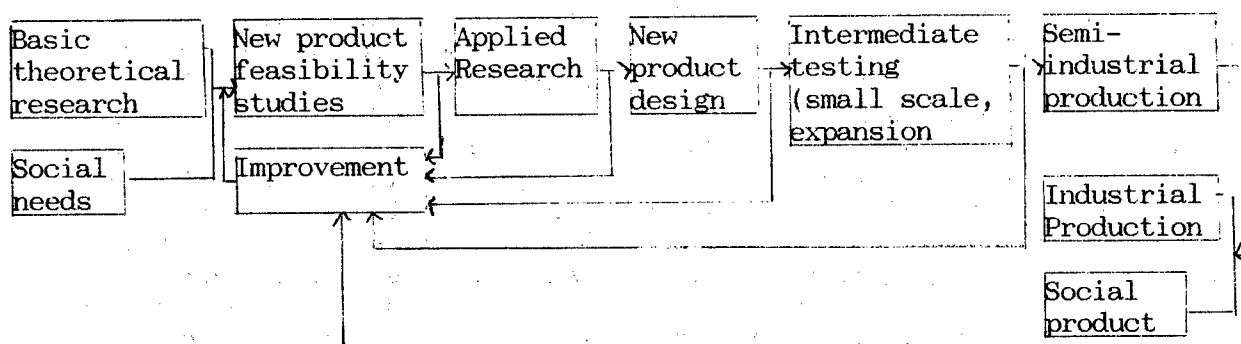
It can be seen in the above illustration that scientific research work includes everything from basic research to technical development, that is, stages one to five. A frequent problem in the past as well as the present is the lack of a link between stages five and six and between the previous and following stages, so that the relationship between scientific research and production frequently is broken here. Scientific research departments often are unable to adapt their scientific research achievements to the needs of production and are not sufficiently concerned with the latter. Moreover, enterprise plants and mines generally carry out very little design and testing for various reasons and always hope to "be prepared for everything." This has made it quite hard to extend the application of scientific research achievements. Statistics from relevant departments indicate that there are 3,000 to 4,000 major S&T achievements every year in China, but usually only 10 to 20 percent are extended well into economic construction. Why is the extension and application of S&T achievements so difficult? Why is the success rate so low? There are of course many reasons for this, including questions of people's ideological understanding, questions of state economic systems and economic policies and so on. It cannot be denied, however, that the main problem is the breakdown in the stages of the materialization process of scientific research achievements. This also is true of the incomplete

bridge of pilot plants between scientific research and production. The historical experiences of other countries indicate that the United States spent 97 billion dollars on scientific research during 1984. About two-thirds were used for research development, and about one-half of the research development expenditures went to expand intermediate testing and development research. (1) It is commonly felt in Japan that there is a 1:10:100 ratio between discovery and invention, intermediate testing and true development into formal production in the total demand for manpower, materials and finances. (2) Their experiences are not only a profound and concrete illustration of the importance of intermediate testing but also of the real need to provide fixed measuring marks and assistance in manpower, materials and financial needs. It is not unusual, therefore, that scientific research units there see their primary mission as using intermediate testing as a major bridge between scientific research and production so that pilot plants assume responsibility for converting knowledge achievements into material products. For this reason, channels between scientific research and production must be opened up to build a bridge of pilot plants. This is required by the development of S&T as well as of the modernization of social enterprises. In contrast, if the pilot plant bridge is a poor one, it will be hard for scientific research achievements on "this shore" to reach the "other shore" and continually use new technologies and new products to transform traditional enterprises and outfit new enterprises. To permit further clarification of the orientation, status and role of pilot plants, their tasks can be divided into the five areas below on the basis of actual experience.

1. Trial manufacture, testing and verification of the scientific research achievements of laboratories--new products and new equipment.

2. Small-scale production and management of new products and new equipment.

3. Organizing technical training classes for social enterprises to spread and popularize knowledge of new technologies and train basic operational personnel or carry out demonstration work.

4. Manufacture, processing and maintenance of the equipment and instruments needed for research topic experiments.

5. Make full use of the potential of pilot plants, work to coordinate tasks with the outside and develop technical services.

These five tasks can be divided into inspection, design, trial manufacture, small-lot production (forming complete production technologies that include scientific theory, technology and technical documents), extension and management, information transfer and offering demonstrations. If pilot plants can play these roles fully, I feel that it is entirely possible that all links between scientific research design, development and production can be closely integrated to build good bridges between scientific research and production and provide a positive solution to the situation of "estrangement and mutual desires."

III. Science, Production and Economic Results

When can it be said that pilot plants have completed these goals and tasks? Concerning development orientations, they have obvious characteristics that

are different from social enterprises. On the one hand, all of the technical activities of pilot plants must meet scientific requirements. Scientific research achievements from the laboratory generally fall into the categories of technical development, creation of new tools and the development of new products. During the process of trial manufacture in plants, they also require that they observe scientific and technical laws and that comprehensively apply many related scientific principles, including the principles and methods expounded by the natural sciences, engineering technology sciences, social sciences, economic sciences, human sciences, aesthetics and psychology. Moreover, it is only in this manner that scientific research achievements can be converted into modernized material products and guarantee and improve product quality. On the other hand, pilot plants also must pay special attention to meeting the needs of production. From the perspective of satisfying the production requirements of social enterprises for a single type of product, the process of converting scientific research achievements into material products in the plants generally requires that the products have optimum performance, maximum reliability, lowest energy consumption, least costs and so on. Moreover, only by doing so is it possible for pilot plants to assist social enterprises in substituting new products for old products and continually achieve escalating changes in enterprise products.

From the perspective of the need to satisfy the needs of science and production, identical work is involved in intermediate testing and scientific research offices in that the problems that must be solved are those that have not been generated by or solved by social enterprise production. For this reason, the technical activities of pilot plants may be said to involve a continuation of laboratory exploration and creation. Added to the continual changes in modern technology, laboratories must adapt to new situations in technical development and their research topics must undergo continual change. For these reasons, there is a largely indeterminate quality to intermediate trail production throughout its activities and processes, which means great variability in planning for the plants, instability in their testing work, imbalances in processing and so on. This presents a myriad of constricting conditions on the workers, technical personnel and managers of the plants and requires them to complete a variety of tasks under continually changing conditions.

Given the above characteristics of pilot plants, the question of how to improve the economic results of the plants in a situation of reforms in scientific research systems has become an extremely acute problem. Originally, improvement of economic results was the foundation for all economic activities under the socialist system, and there is no doubt that this also is the foundation of pilot plants. So, how can the problem of economic results be dealt with in pilot plants? A large number of facts now show that a failure to achieve a good solution to this problem will force a re-orientation or a premature end. Historical experiences show that allowing intermediate testing to play the role of abridge requires that we suggest the following countermeasures and measures.

First, we must confirm the overall standards for evaluating pilot plants solve questions concerning the accurate evaluation of their economic results.

The tasks for which pilot plants now are responsible of course mainly concern completion of trial manufacture of new products, experimental equipment manufacture and processing, maintenance tasks and so on before they can undertake definite outside tasks according to the capabilities and potentials of the plant. For a long time to come, however, institute tasks completed by the plants have a low value of output and small profits, and often involve losses. Given these facts, evaluation of pilot plants on the basis of economic results alone is sure to cause problems in economic accounting. In fact, many people in the plants are insensitive to general tasks assigned by research academies and are concerned only with engaging in high profit topics or competing for outside tasks. In contrast, the plants suffer increasing losses if they are not concerned with "bargains" in institute processing tasks, and employee initiative and labor productivity both are low. Moreover, some people feel that relatively independent economic accounting in the plants may obstruct scientific research work and advocate that self-responsibility for profits and losses should not be calculated for research academy tasks, and so on. The appearance of these new problems in pilot plants under the new situation illustrates that simply employing indices of economic results to evaluate work in these plants is not enough. We feel that new comprehensive evaluation standards should be decided upon to evaluate the achievements and value of pilot plant work. The content of such evaluations should include the following aspects.

1. Technical evaluations. These mainly involve evaluations of the technical levels of products, including advanced qualities, reliability, applicability and prospects for extension.

2. Economic evaluations. These require evaluation both of the microeconomic results and the macroeconomic results of a product. They require analysis of the development process for a product, but even more important is a need to examine the costs of the total life cycle of the product after it is transferred and goes into production (including links such as operationalization, operation, maintenance and so on).

3. Social evaluations. These mainly involve analysis and evaluation of a plant on the basis of policies, laws, environmental ecology and other social consequences.

4. Human engineering evaluations. These mainly involve evaluating the rationality, suitability and safety of a new product from the perspective of operators and users.

5. Work task evaluations. These mainly involve standards for speed, quality, costs and service attitudes during the completion of scientific research and production tasks assigned to the academies.

In summary, failure to start with the special characteristics embodies in the pilot plants and failure to focus on and consider evaluation of their developmental orientation will make it very hard for these plants to survive.

Second, questions concerning avenues for the improvement of economic results in the pilot plants must be resolved.

To be sure, the implementation of relatively independent economic accounting in pilot plants and continued improvements in their economic results are related to first-class and important issues like the adherence of these plants to their own developmental orientations, promoting the rapid orientation of new products toward the economy and toward markets, direct service to society and so non, and they also are the foundation and prerequisite for the pilot plants, ability to motivate worker initiative and creativity to improve labor productivity. In consideration of the characteristics of pilot plants, economic accounting in them can be carried out using the following two forms; one form involves integration of laboratories and plants to convert them into unified accounting units, which would have many benefits for the development of new technologies and the rapid conversion of S&T achievements. The other form resembles the current situation, with economic accounting done independently from the laboratories. Adoption of this form, however, requires a solution to the question of economic input in the pilot plants. We feel that the following channels should be opened as economic sources of improvements in the economic results of these plants.

1. Input from state expenditures and patent input. The research expenditures entrusted to scientific research units by the state should be allocated to pilot plants in a specified manner and proportion. Patents obtained by a laboratory are the joint property of the scientific research unit. The laboratory should deduct a specific proportion and the plants also should receive a specific proportion.

2. Pilot plants should become integrated trial manufacture--production-- management entities. (1) After the achievements of laboratories are materialized through trial manufacture in pilot plants, they can enter the market directly in a compensated form because the pilot plants are the bridges between scientific research and production as well as the production units of scientific research units. Continually placing pilot plants' new products and equipment on the market and sending them into social industrial and mining enterprises conforms with laws and has many advantages. After these products and equipment are sold, however, income deductions should be made for the quality and amount of labor expended by each of the plants and laboratories. To achieve this, pilot plants should combine good expansion of experiments and technical development work with a focus on product management work.
(2) Pilot plants should be continually engaged in small-lot production and the cycle of product production should be about 3 years. The laboratories also should be compensated according to the principle of exchange at equal value from the income from products.

3. Make an appropriate expansion in the proportion of outside tasks and develop broad-ranging technical services. We stress increases in the three areas outlined above to increase and solve economic sources in the pilot plants, and it is only in this manner that these plants will be able to strive for an orientation of industrial enterprise economic accounting and continually improve economic results, thereby adhering to the orientation of pilot plants and assuring their vital existence.

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OFFICIAL ON USING S&T RESOURCES FOR ECONOMIC CONSTRUCTION

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[Report by Jin Tao [6855 3447] on interview with Wang Yiming [3769 5030 2494], National People's Congress representative, party group secretary the Kunming branch of the Chinese Academy of Sciences: "Science and Technology Army Should Throw Itself into the Main Battlefield of Economic Construction"]

[Text] Forty-four-year-old Wang Yiming assumed the leadership of the Kunming Branch in 1984. Before that she had been pursuing research in optics, participated in the optical design of an astronomical telescope and was responsible for the topic "Application of Spot Interference Technology in Astronomy." Now she is the primary authority at the Kunming Branch, which has over 900 researchers, an observatory, a plant institute, a zoological institute and an ecology institute. She thinks most of all about the upcoming reform of the science and technology system.

Wang Yiming says that according to the reform scheme recently put forward by the Chinese Academy of Sciences, all research institutes will be divided into developmental, resource and environmental survey, and basic research types. The institutes subordinate to the Kunming Branch belong primarily to the second type, so they carry out research on developing resources, the environment, ecology, and agriculture and the accumulation of basic materials to provide scientific bases for macro policymaking in land management, resource development, regional planning, and comprehensive development of agriculture. Since Yunnan has a "plant kingdom" and "animal kingdom" not shared by the entire country, biological research can be very closely linked with national economic construction, play a role in stimulating the local economy, and form a strong and solid national corps. She affirms confidently that there are great hopes for the science and technology army to throw itself into the main battlefield of economic construction.

I asked her if there were any difficulties in this area.

She smiled and said: "I have to admit that there are many difficulties. Mainly, it is that the current science and technology system is out of step with production and lacks an intermediate environment for converting the results of science and technology into productive forces."

Wang Yiming cited an example. A few years ago the plant institute produced a "Tianfu [1131 1650] development laboratory" from a plant, and when the relevant enterprises in Sichuan learned of it they immediately invested in it and subsequently went into production with clear economic benefits. As a result, some leaders asked why the results of this project should be promoted outside the province. This shows that the risky investment in science and technology research has not yet attracted sufficiently serious attention from some comrades, and in the economically undeveloped areas in particular there are more misgivings in this area. Actually, in the present situation wherein products are constantly being updated and competition is fierce, the more one gives serious consideration to promoting the results of science and technology and relies formly on the idea of scientific and technological advance, the more one will benefit. Wang Yiming said: "This point should be fully acknowledged by the leaders of many enterprises for scientific and technological advances to be able to provide vitality to enterprises. At the same time, we should formulate relevant policies for converting science and technology results into productive forces."

When we came to the issue of how better to put the science and technology army into the primary battlefield of service to national economic construction, Wang Yiming admitted that there are two problems that must be resolved.

She said: "First of all, to put superior science and technology personnel in the front line of economic development, it is necessary to change some old traditional concepts, such as the notion that engaging in basic theoretical research is of a higher order than development. This is a prejudice. Or again, when reviewing professional titles, we should change our practice of only recognizing articles and not giving serious considera- tion to development results. In terms of the science and technology personnel themselves, we should also change the old idea of slighting business and honoring education; for administrative personnel, we should strive gradually to utilize people who are familiar with the economy, markets, pricing systems and economic information." Wang Yiming added: "Second, the research units of the various systems are very numerous at present; manpower, material, and investment are scattered; and the same topic is researched in duplicate at a low level. This situation must be changed."

She stated emphatically that in the management system, we should coordinate forces to develop a superiority that is scientifically complete and broadly adopts the advantages to form a "fist." This is extremely important for better serving national economic construction.

8226/9835

TAN JIAZHEN, MA DAYOU DISCUSS S&T REFORMS

40082110d Beijing GUANGMING RIBAO in Chinese 2 Apr 87 p 2

[Article by Li Shuxi [2621 2885 0823]: "Tan Jiazhen [6151 1367 2823] and Ma Dayou [7456 1129 3731] Discuss Reform of the Science and Technology System"]

[Text] Tan Jiazhen: Smash the "Three Eight Line"

When talking about intensifying reform of the system, Prof Tan Jiazhen, National People's Political Consultative Conference Committee member and deputy chairman of the China Democratic League Central Committee, said: "First, I want to talk about the past and tell you a little story." Old Tan smiled slightly, and began to tell his story in a thick Shanghai accent.

"In 1956, at the time of the National Propaganda Work Conference, there was a squabble over 'turf.' Chairman Mao and the leadership comrades of the Central Committee met in the Huairentang with some of the comference representatives, primarily scientists and educators, and I was one of them. At the meeting, Comrade Yang Xiufeng [2799 4423 1496], minister of higher education, and Comrade Guo Moruo, president of the Chinese Academy of Sciences, got into an argument over the matter of people. The hearing of these two old people was poor, so when they began to talk, the pitch was very high. Yang said, 'Many good scientists have transferred from the educational system to the Academy of Sciences.' Old Guo said, 'How can science develop if it doesn't gather together people?' Chairman Mao mediated with a smile: 'Don't fight, use the three eight line as the border; neither is ready to hold.'"

Old Tan explained: In his joke, Chairman Mao used an analogy to stop the dispute. He had repeatedly spoken of the matter of combining education with research and production. But I said that for a long time there had been an invisible "three eight line" separating science and education, and although in recent years we have advocated reform of the system and the combination of science and research, this problem still has not been truly resolved. There are also many places where there is separation, wrangling, and disputes.

Old Tan said that the era in which the world has entered the new technological revolution is also an era of intense competition, and competition also requires

that such links as research, education and production be closely linked in order to achieve superiority, and that such linkage means changes or reform of the system. The U.S. "Star Wars" plan is a major domestic linkage, Western Europe's "Eureka" plan is a linkage of research and production with educating talent between countries. Eastern Europe and Japan are also developing their own linkages. Thus, why don't we Chinese begin to create linkage? And why is it so difficult to envision and establish the policies for our linkage?

Old Tan said we should search for the causes in the traces of China's feudal thinking and petty bourgeois concepts. The departmental selfishness of some research units and production units is severe, and when linking up they are eager for quick success and their own benefit; they do not see the advantages immediately and are not willing to accomplish it; they lack a view of the whole picture; some exclude each other, some research results they would rather transfer to foreign but not domestic production. It should be said that many of our inventions have been recognized, but few of them have really been put into production so that society can see the results, and many remain only patents and prizes. There are two reasons for this: First, the inventions of many inventors are a result of their specializations and preferences and not of the needs of production, so that these inventions are not ready to go into production or the production conditions may not have been taken into account. Second, the dislocation between research and production makes the process of putting technology into production very slow. This problem involves the obstacles of petty bourgeois and departmental selfish thinking as well as the problem of the system. I think that first of all we should change the thinking. We should not overlook the interference of feudal small farmer thinking in reform. Our talk of reform and opening up involves not only opening up to the outside, but also opening up between the areas of research, education and production domestically to form an organic linkage. Theoretically speaking, socialism should have a higher degree of linkage than capitalism, and if we can realize this type of linkage, our productive forces will develop and our competitive ability also will be greatly strengthened.

Ma Dayou: Basic Scientific Research Cannot Be Overlooked

Ma Dayou, member of the National People's Consultative Conference and famous physicist, said that in reform of the science and technology system, emphasis on applying scientific research and an orientation toward production is undoubtedly important, but by all means we cannot overlook research in basic science.

He began talking about the rapid developments made by China in research on superconducting materials. Ma Dayou said that superconductor research had developed to the stage of applications, and China's results are at advanced world levels. However, a journey of a thousand miles begins with but one step, and our research on superconducting rests on a process of basic research preparation. In the fifties, China established a low-temperature laboratory at the Physics Institute, we produced a lot of equipment by ourselves, and many researchers received excellent training there. From the time this laboratory was established, one could say that it was first-class

world level. If this is the case with superconducting, the development of other sciences, such as nuclear research, is the same--that is, it all developed from basic scientific research.

Professor Ma said: In recent years we have had a tendency to overlook basic science. The funds necessary for basic scientific research have been few; we should always spend a little capital on some equipment and buildings, but conditions in this area are very meager. Now many of the research expenditures and administrative expenditures for research departments are lumped together so that administrative expenditures dominate research expenditures, and this problem needs to be corrected.

Finally, Professor Ma said that basic research cannot always be carried out for quick returns, but capital should be provided. It appears that basic research does not provide immediate results, but it has a long-term promotion effect on economic development. Current policy problems regarding expenditures and other areas have influenced the initiative of university students, graduate students and researchers in basic scientific disciplines to study and work; some people consider that the prospects for doing basic research are dim, and if this is not resolved it may have an impact on the achievements of the army of science and technology talent.

8226/9835

LESS ENERGY DEPENDENT FARMING PROPOSED

Petroleum Intensive Agricultural Ecosystem

40081009a Liaoning SHENGTAIXUE ZAZHI [JOURNAL OF ECOLOGY] in Chinese Vol 6,
No 3, Jun 87 pp 1-5

[Article by Wen Dazhong [5113 1129 0022], Institute of Forestry and Soil Science,
Chinese Academy of Sciences: "China's Petroleum Intensive Agricultural Ecosys-
tem and Its Improvement", Part I]

[Text] I. Analysis of China's Petroleum Intensive Agricultural Ecosystem

The term "petroleum intensive" agricultural ecosystem is used in this article
to mean the tendency to rely increasingly on mineral energy (particularly
petroleum energy) as a basic technique and product for controlling the agri-
cultural ecosystem.

1. Changes in the Development of China's Agricultural Ecosystem and Inputting
of Industrial Energy

Up until the early 1950's, China's agricultural ecosystem was basically a self-
sufficient or self-sustaining traditional agricultural ecosystem lacking support
from modern industry. Maintenance of such an agricultural ecosystem relied
primarily on solar energy and the flow within the system of biological energy
produced by systematic transformation of solar energy. It was substantially
devoid of inputs into the system of industrial energy or mineral energy (except
for an extremely small amount of industrial energy used for the manufacture of
simple work tools). The biological agricultural products and byproducts pro-
duced within the agricultural ecosystem were likewise consumed and expended
within the system. The balance of nutrients in the farmland, which was the
backbone of the agricultural ecosystem, was maintained by biological processes
within the system and the recycling of organic materials. The productivity of
this kind of self-sufficient or self-sustaining agricultural ecosystem was
usually fairly low.

China's agriculture has developed greatly during the past more than 30 years,
the level of agricultural productivity rising, in particular. The country's
gross output of grain rose from the 1.13×10^8 of 1949 to the 3.87×10^8 of
1983 for a 3.4-fold increase. Grain output per unit of area sown also rose

from the 1,028 kg per hectare of 1949 to the 3,398 kg per hectare of 1983 for
a 3.3-fold increase. United States grain yields per unit of area sown for
1982 and 1983 also happened to be 3,398 kg per hectare. This means that
China's grain yields reached the level of the country that is generally con-
sidered to be the classic example of a petroleum intensive agriculture, namely
the United States. What changes in China's agricultural ecosystem have
accompanied the rapid increase in agricultural output? First of all, high
yield crops and high yield strains have been universally selected for use in
agricultural production, and the advantages in increased yields that are pos-
sible from the use of these new yield strains have been realized through the
application of plentiful nutrients and the effective control of diseases,
insect pests, and weeds. In addition, an increase in the area of crops that
take nutrients from the soil, and a decrease in the area of crops that put
nutrients back into the soil has destroyed the self-sustaining low level
nutrient balance that formerly existed. Consequently, the large scale appli-
cation of chemical fertilizer has become a mainstay of grain production. The
high correlation between the year-by-year increase in the amount of chemical
fertilizer used and grain output since the early 1950's testifies to this. The
use of new strains of high yield hybrid crops and changes to the traditional
crop rotation system and farming system weakened the self-regulatory ability
and the stability of the agricultural ecosystem itself. Effective control of
diseases, insect pests, and weeds to insure high yields inevitably meant the
use of agricultural pesticides and herbicides. In addition, in order to
improve production conditions and labor conditions in agriculture, inputs
into the system of machinery, petroleum and electric power increased rapidly.
China's grain output has basically increased steadily year-by-year, and these
industrial energy inputs into the agricultural ecosystem have also steadily
increased at an even faster speed. China's gross output of grain doubled
between 1965 and 1983, but the input of chemical fertilizer into the agricul-
tural ecosystem increased 8.5 fold. The amount of pesticides used tripled;
the amount of diesel fuel used in agriculture increased sevenfold, and the
amount of electricity increased 12 fold (see Figure 1).
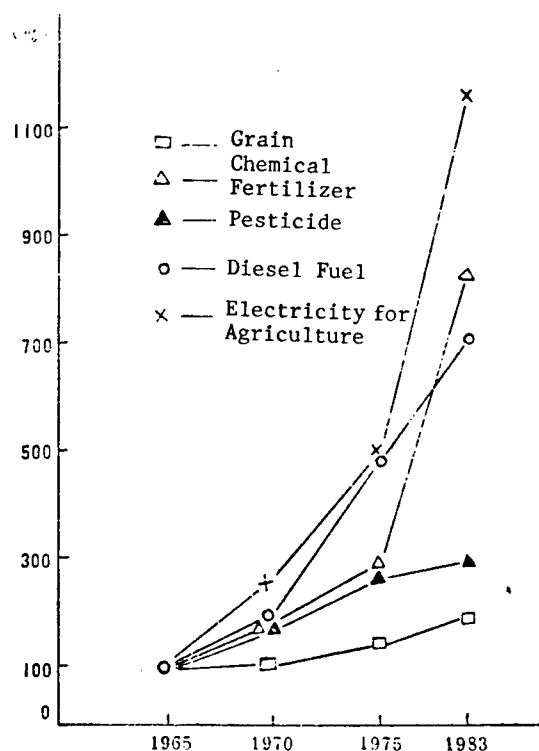
Figure 1. Comparison Between Increase in China's Gross Output of
Grain and Consumption of Chemical Fertilizer, Pesticides, and of
Diesel Fuel and Electricity Used in Agriculture

2. Current Input of Industrial Energy into the Country's Agricultural Eco-
system

In view of the basic meaning of the term "petroleum intensive agriculture,"
analysis of industrial energy inputs consisting primarily of petroleum energy
into the country's agricultural ecosystem is the most basic method for deter-
mining whether China's agriculture is a petroleum intensive agriculture. The
author estimated the industrial energy input into the grain crop system, which
is the most fundamental part of China's agricultural ecosystem, and then made
a comparison with the situation in the United States. (Table 1).

Inputs of industrial energy during the entire process from sowing to harvesting
and threshing may be divided into two major categories. The first category
covers direct industrial energy (such as petroleum and electricity); the second
category covers indirect industrial energy (such as machinery, chemical ferti-
lizer, and agricultural pesticides). Calculations based on comparable energy
values (i.e., figured in terms of conversion standards used in the United
States to derive energy equivalents for all kinds of industrial goods and
materials), total industrial energy input per hectare of sown area for the
growing of grain crops in China in 1982 (including both direct industrial
energy and indirect industrial energy) was 1.073×10^{10} J, which equaled 250
kgs of petroleum.

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Table 1. Comparison Between China and the United States in Industrial Energy Inputs
Per Sown Hectare of Cereal Grain Crops

| Item | China (1982) | | | U.S.A. (1975) [8] |
	Quantity/ha [hectare]	kJ/ha 1 (Calculated with comparable energy values)	kJ/ha 2 (Calculated with actual energy values)	kJ/ha
Industrial Input				
Farm Machines & Tools	9.75kg [3]	823,403	1,510,305	1,793,711
Diesel Fuel	41.05L [4]	1,961,798	1,961,798	2,752,726
Gasoline and Lubri- cating Oil	3.56L	150,682	150,682	71,954
Nitrate Fertilizer (figured in terms of pure nitrogen)	74.47kg	3,742,173	6,595,580	3,074,933
Phosphate (figured in terms of P_2O_5)	25.00kg	314,025	621,422	492,391
Potash (figured in terms of K_2O)	5.12kg	34,296	34,296	357,067
Limestone	-	-	-	219,466
Irrigation	- [5]	-	-	1,135,866
Pesticides and Herbi- cides (net amount)	5.46kg[6]	2,135,450	2,135,450	1,206,635
Drying	-	-	-	620,853
Electricity	126.06kwh[7]	1,511,130	1,803,010	851,619
Transportation of supplies used in agriculture	54.21kg	58,237	69,910	146,558
Total Industrial Input		10,731,194	14,882,453	12,723,779
Grain Output		44,912,107	44,912,107	47,586,494
Output		0.239	0.331	0.267
Grain Energy Output/ Industrial Energy Input		4.19	3.02	3.74

Note: (1) By comparable energy values is meant the conversion values commonly used by the United States and others for calculating the input of industrial energy into the agricultural ecosystem. (For details, see Wen Dazhong, 1985);

(2) Estimate of the actual energy value of materials currently used in Chinese agriculture based on relevant data for China's current energy consumption and energy utilization rates for major industrial products, with reference to the calculation methods used to derive values for various materials used for agricultural purposes in the United States. (Please see Wen Dazhong, 1986)

(3) The number of major machines and tools used in farm operations, and depreciation for the period of effective use of all kinds of machines and tools were used as the basis for calculating a weight equivalent to consumption for the year, thereby deriving a base figure average for the farmland area sown nationally.

(4) Based on total amount of diesel fuel used for farming purposes nationally minus the amount used for forestry, animal husbandry, commune and brigade enterprises, and for rural tractor high-way transportation, the country's total sown farmland area then being used as a base figure area to derive the quantity of diesel fuel used per hectare.

(5) Energy used for irrigation has already been included in farm machinery, petroleum and elec-tricity energy.

(6) Based on actual amount of consumption for the year, using an average 50 percent purity value.

(7) Use of electricity for crop production includes electricity used for drainage and irrigation, and for threshing. Electricity used for drainage and irrigation amounts to approximately 40 per-cent of total rural electricity use. The amount of electricity used for threshing is figured at approximately one-half of the amount of electricity used for the processing of agricultural products.

(8) Based on the input of industrial energy used for major grain crops in the United States in 1975 as reported by Pimentel and Pimentel (1979), as well as on the area sown to major grain crops in the United States for that year using weighted averages.

This was 84 percent of the amount of industrial energy per hectare of sown crop land used in the United States in 1975. Consumption of industrial energy to produce grain stated in terms of energy expenditure per unit of production shows the consumption of 0.239kJ of industrial energy per 1 kJ of grain produced in China in 1982. This was 90 percent of the 1975 consumption figure for the United States. As a part of the input of industrial energy into grain production, the amount of nitrogenous fertilizer used per hectare of sown farmland in China in 1982 (74.5 kg of pure nitrogen) was 22 percent higher than for the United States in 1975. The average amount of pesticides and herbicides used was almost two times again the amount used in the United States (See Table 1).

It is especially noteworthy that the energy use rate regarding our country's industrial production (including related industrial production that supports agriculture) is considerably lower as compared to several advanced nations. This is the analytical method to determine the actual energy consumption capacity in the manufacturing process of various industrial products in the agricultural ecosystem. Moreover, on this foundation, the actual energy converted value of various industrial products to support agriculture can be determined, and the actual mineral energy consumption value of the 1982 average grain crop per hectare sown can be calculated. (See Table 1). The actual total amount of mineral energy consumed per hectare of sown crop land was 1.488×10^{10} J/ha, 17 percent higher than consumption in the United States during 1975. Figured in terms of the actual consumption of industrial energy per kJ of grain, it is 24 percent higher than for the United States in 1975. (See Table 1).

To recapitulate the foregoing, in terms of both the level of productivity and the level of consumption of industrial energy, to a certain extent the situation in China's agricultural ecosystem approaches or exceeds that of the classic "petroleum intensive" agricultural ecosystem of the United States. If one says that the United States has a petroleum intensive agriculture, one also has to acknowledge that China's agriculture is also essentially petroleum intensive. Particularly inasmuch as China's current utilization rate for mineral energy is fairly low, the level of actual consumption of industrial energy for agricultural production is greater than in the United States; thus, China has a more "petroleum intensive agriculture" than the United States.

3. Essential Characteristics of Inputs of Industrial Energy Into China's Agricultural Ecosystem

a. The make-up of inputs of industrial energy has as its goal an increase in yields per unit of area.

Table 1 shows that direct industrial energy (diesel fuel, gasoline, and electricity) amounts to one-third the total input of comparable industrial energy per unit of sown area in China, indirect industrial energy (machines, chemical fertilizer, and pesticides) accounting for two-thirds. Nitrogenous chemical fertilizer alone accounts for 35 percent of the 58 percent total input of chemical fertilizer and pesticides used directly to increase crop yields. Such a make-up of industrial energy input demonstrates that increase in yields per unit of area is the main goal in the use of industrial energy.

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b.   A Petroleum Intensive Agriculture With a Very Low Labor Productivity Rate

The most striking difference between the petroleum intensive agriculture of
China and the petroleum intensive agriculture of the United States lies in the
agricultural labor productivity rate. The United States uses an average of
only 10 man hours per hectare of farmland from sowing to harvesting, while
China uses at least 1,000 man hours in addition to a substantial amount of
animal power. This means that America's agricultural labor productivity rate
is approximately 100 times again that of China. Among the industrial energy
inputs into the growing of crops in the United States, energy used in machine
operations (including both direct industrial energy in the form of petroleum
and indirect energy in the form of agricultural machines) amounts to one-third
of the total industrial energy input. In China, however, the comparable indus-
trial energy input for machine operations per hectare of farmland sown to grain
crops amounts to 27 percent of the total industrial energy input. (See Table
1). Obviously such a difference is caused not only by differences in the input
of industrial energy, but results, more importantly, from numerous social, eco-
nomic and technical factors.

c.   Differences in Industrial Energy Inputs Into the Farming System in Different
Parts of the Country

The above situation with regard to industrial energy inputs outlines the over-
all situation prevailing in China's farming system. But there is a very great
variation in both natural and socio-economic conditions in individual parts of
the country; consequently, there is also a very great difference in inputs of
industrial energy into the farming system. This is prominently manifested
both in differences in inputs of industrial energy per sown hectare, and in
differences in industrial energy utilization rates.

Using calculation methods similar to those described above, the writer figured
the actual input of industrial energy per hectare of sown land in each province
and region of the country, and divided up the amount of industrial energy input
in terms of high, intermediate, or low. Areas in which industrial energy input
was greater than 1.7×10^{10} J/ha were designated high input areas; areas in
which industrial energy input was between 1.0×10^{10} J/ha and 1.7×10^{10} J/ha
were designated intermediate input areas; and areas with an input of less than
1.0×10^{10} J/ha were designated low input areas. He used these designations to
draw a map showing industrial energy input areas for the grain crop system
throughout the country. This map, which appears in Figure 2, provides a
natural division of the country into three substantially contiguous areas on
the basis of the input of industrial energy per hectare of sown land for each
province and region. High input coastal areas include Liaoning, Hebei,
Shandong, Jiangsu, Zhejiang and Fujian provinces, plus suburban Beijing, Tian-
jin and Shanghai. In the high input coastal areas, except for the suburban
areas of Shanghai and Beijing in which the input of industrial energy is
highest (averaging 4.17×10^{10} J/ha in Shanghai and 3.16×10^{10} J/ha in Beijing),
the province having the highest input was Jiangsu, where it was 2.54×10^{10} J/ha.
Medium input areas included Henan, Anhui, Hubei, Hunan, Guangdong, Guangxi,
Sichuan, Jilin, Shanxi, Shaanxi, and Jiangxi provinces. Low input border
regions included Heilongjiang, Nei Monggol, Gansu, Qinghai, Ningxia, Xinjiang,

Yunnan, Guizhou, and Xizang, the lowest input being in the Xizang Autonomous Region where the input of industrial energy per hectare of cultivated land was only 4.6×10^9J/ha. This was only one-ninth the input in suburban Shanghai, and one-fifth the input in Jiangsu Province.

EE High Input Area (Greater than 1.7×10^{10}J/ha)
⊏⊐ Intermediate Input Area (Between 1.0×10^{10} - 1.7×10^{10}J/ha)
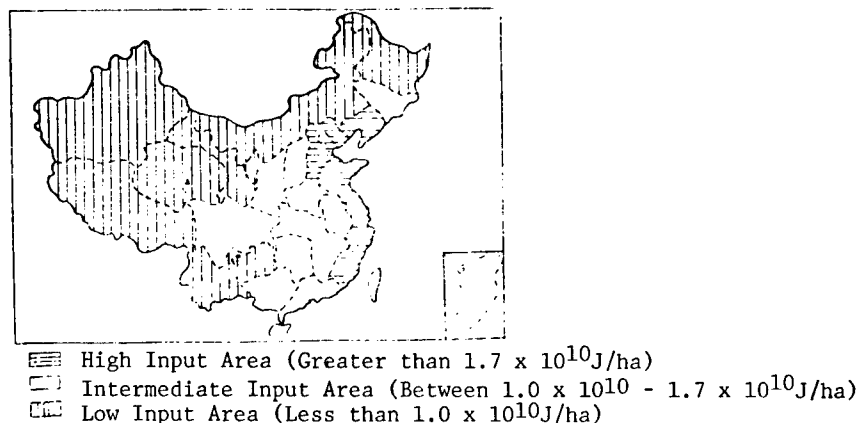⊏⊏⊐ Low Input Area (Less than 1.0×10^{10}J/ha)

Figure 2. Map Showing Area-by-Area Industrial Energy Inputs to the Chinese Grain Crop System

The amount of industrial energy input per unit of cultivated land area shows the extent to which industry supports agriculture. However, it does not reflect the efficiency of inputs of industrial energy. If the efficiency of industrial energy inputs into grain crop production for all provinces and regions of the country (the actual amount of grain output per unit of industrial energy input) were charted, and the efficiency of each province and region rated high, intermediate, or low, those provinces and regions with an energy efficiency greater than 4.5 being rated high efficiency areas, those with an energy efficiency of between 3.0 and 4.5 being rated intermediate efficiency areas, and those below 3.0 being rated low efficiency areas, the whole country could be generally divided into three regions from the coast inward. These three regions would be as follows: the high efficiency border regions; the intermediate efficiency middle region, and the low efficiency coastal area (see Figure 3). The regional situation turns out to be just the opposite of the regional situation for the amount of industrial energy input. However, there are differences among the provinces and regions included in each of the regions. The high efficiency border region includes Xizang, Yunnan, Guizhou, Sichuan, and Xinjiang, the area of highest efficiency being the Xizang Autonomous Region with a 7.11 efficiency rating. The intermediate efficiency region includes Heilongjiang, Jilin, Nei Monggol, Ningxia, Gansu, Qinghai, Jiangxi, Hunan, Hubei, Shaanxi, Anhui, Zhejiang, Guangdong, and Guangxi. The low efficiency region includes Liaoning, Hebei, Shandong, Jiangsu, Fujian, Henan, and Shanxi provinces as well as suburban areas of Beijing, Tianjin and Shanghai, the lowest being suburban Beijing with a 1.60 rating, and Hebei Province with a 1.88 rating.

It is clear from the foregoing pattern of distribution that except in a few cases, usually it is the areas having fairly good natural conditions and that

are rather well developed economically that make the greater inputs of indus-
trial energy to the farming system, but that have a relative low energy
efficiency. However, it is in border regions where natural conditions are
relatively poor and that are not economically developed that the input of
industrial energy into the farming system is relatively small, but where
efficiency is relatively high. Clearly, results would be better from
increasing the amount of industrial energy inputs into the agricultural eco-
system of border regions than from continuing to increase the amount of in-
puts into coastal regions. This will be an important matter in the country's
macroeconomic agricultural development strategy.

    --High Efficiency Area (Greater than 4.5)
    --Intermediate Efficiency Area (Between 3.0 and 4.5)
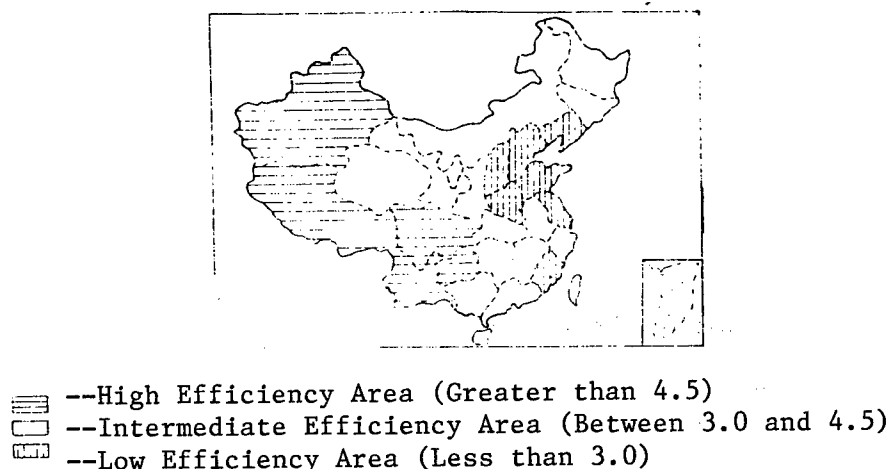   --Low Efficiency Area (Less than 3.0)

Figure 3. Map Showing Area by Area Efficiency of Industrial Energy
Inputs Into the Chinese Grain Crop System

d. Unreplaceable Energy Consumption; by China's Farm Crop System

Total expenditure of unreplaceable energy in China for 1982 was 6.1637×10^8t
of standard coal, with coal accounting for 73.92 percent, petroleum 18.69 per-
cent, natural gas 2.56 percent, and hydroelectric power 4.85 percent.
Unreplaceable energy directly used in agriculture amounted to approximately
1.6×10^7t of standard coal or 2.5 percent of total consumption of unreplace-
able energy. If the foregoing analysis is used as a basis for considering
the direct and indirect consumption of unreplaceable energy by the agricul-
tural ecosystem, China's consumption of unreplaceable energy for grain produc-
tion along amounts to 5.76×10^7t of standard coal. This is 9.3 percent of
the whole country's total consumption of unreplaceable energy, and equal to
half of the country's total petroleum consumption for the year. The whole
farm crop system's consumption of unreplaceable energy totaled 7.35×10^7t of
standard coal, or 12 percent of the whole country's total consumption of
unreplaceable petroleum, the equivalent of two-thirds the country's total
consumption of petroleum for the year. Obviously, this is no small figure.

By the end of this century, the gross output value of China's national economy will quadruple, but production of unreplaceable energy will only double. Consequently, for a fairly long period of time, the country's industrial energy will be in fairly short supply. Efforts to conserve industrial energy will be a long-term strategic effort in China. Efforts to raise the efficiency of industrial energy inputs into the agricultural ecosystem should also be regarded as an important integral part of the country's overall conservation strategy. Improvement of the country's current petroleum intensive agriculture and development of the country's modern agriculture should become a fundamental task on the front line of China's agriculture.

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(Draft Accepted 16 January 1987)

(Postscript)

The 5 January 1987 issue of KEJI RIBAO [SCIENCE AND TECHNOLOGY NEWS] printed remarks obtained in an interview of the author of this article by a correspondent from that newspaper as follows: "China entered the petroleum intensive agricultural age at the end of the 1970's. Now particularly serious attention should be given to research and development of a series of ecological agricultural techniques for using the smallest possible amounts of chemical fertilizers and pesticides in order to change the high energy consumption situation in agriculture." This magazine will subsequently publish two fairly detailed articles by the author that study and explore the foregoing problems. It is hoped that they will stir concern and lead to discussion.

Ecological Agrotechniques Development

[Article by Wen Dazhong [5113 1129 0022], Institute of Forestry and Soil Science, Chinese Academy of Sciences: "China's Petroleum Intensive Agricultural Ecosystem and Its Improvement", Part II]

[Text] II. Development of Ecological Agrotechniques and Improvement of China's Petroleum Intensive Agriculture

The first part of this study analyzed the issue of China's "petroleum intensive" agricultural ecosystem. This article explores improvement of China's petroleum intensive agriculture.

1. Two Attitudes For Dealing With Petroleum Intensive Agriculture

The half century old petroleum intensive agriculture of advanced countries in Europe and America that has developed from mineral energy has been enormously successful. This success has been prominently manifested in: (1) Marked increase in outputs of agricultural products. Corn yields in the United States today are three times again as large as in 1945, and wheat yields have doubled in 40 years. (2) An extremely great rise has taken place in the agricultural productivity rate. Corn production in the United States from sowing to harvesting requires only 12 man hours of labor per hectare, or 1 percent of the man hours required by traditional methods of producing corn. (Wen Dazhong, 1986).

However, accompanying this development of petroleum intensive agriculture has been a series of resources, environmental and ecological problems that have been prominently manifested in the following ways: (1) Increasingly serious erosion of farmland. (2) Ever larger scale use of chemical fertilizer and pesticides. (3) Increasingly serious damage to the environment from agricultural production. (4) Rise in the consumption of petroleum energy. (Please see Wen Dazhong, 1985).

More than 30 years of development of a Chinese style petroleum intensive agriculture has made major contributions in solving the problem of feeding 1 billion Chinese. With 8 percent of the world's cultivated land and 15 percent of the grain crop growing area, it has produced 21 percent of the world's total output of grain, and supported one-fourth of the world's population.

Though there are very great differences between Chinese style and American style petroleum intensive agriculture, the resources, environmental, and ecological problems that this kind of agriculture occasions are the same. Inasmuch as chemical fertilizer and pesticides (including herbicides) are the industrial energy inputs that have the greatest affect on resources, the environment and the ecology, and since the amount of chemical fertilizer and pesticides used in China is far greater than in the United States, the resources, environmental and ecological problems that China's petroleum

intensive agriculture presently faces are no fewer than in the United States. Though study of the effects of farmland soil erosion on agricultural resources, damage to the environment resulting from chemical fertilizer and pesticides, and harm to the human body done from eating food that has been grown using them has not been as pervasive in China as studies done in the United States and other developed countries, and though there is a definite difference in the degree to which people in China devote serious attention to this issue; nevertheless, continued efforts to make use of the benefits that petroleum intensive agriculture provides while overcoming some of the problems that petroleum intensive agriculture occasions should be the direction of our efforts.

There are, in a nutshell, two views about the solution to these problems.

One of these views may be termed the "reform" view. It maintains that petroleum intensive agriculture is the main course to be followed for the most part, and that the various problems it occasions can be surmounted; therefore, appropriate actions may be actively taken to overcome and solve the specific problems that arise. The various efforts made by agricultural scientists and practitioners during the past several decades such as the promotion of reduced plowing and no plowing techniques, the use of shelter afforestation and water conservancy or soil improvement measures, the use of agricultural pesticides of high effectiveness and low toxicity, and the development of multiple techniques for the prevention and control of diseases and insect pests in order to improve the agricultural environment, conserve water and soil, reduce pollution from chemical fertilizer and pesticides and reduce consumption of mineral resources, have all been expressions of this idea. These measures have scored remarkable results in practice, with the result that petroleum intensive agriculture has continued and developed. Though these measures and techniques have not been formally termed ecological agrotechniques, many of them do reflect ecological thinking, and the application of certain ecological principles has produced fine ecological results and economic results.

The other view may be termed the "revolutionary" view. It holds that modern petroleum intensive agriculture is an industrial system founded on chemistry, and that this is incompatible with agriculture as a biological system based on biological principles. Thus, not only should a part of this agriculture be improved, but its development should be looked at in terms of agriculture overall (Lovett, 1980). Inasmuch as many of the problems that petroleum intensive agriculture occasions are closely related to the large scale use of chemical fertilizers and pesticides, yet another kind of agricultural practice appeared in European and American countries not long after petroleum intensive agriculture developed. This agricultural practice either does not use any or does not use large amounts of artificially synthesized chemical fertilizers, pesticides, growth regulators or livestock feed additives. Every effort is made to rely on crop rotation, crop stalks and stems, livestock dung, pulse crops, green manure, organic waste from outside the farm, and nutrient-containing rocks, as well as the use of biological methods for prevention and control of diseases and insect pests in order to conserve soil fertility and tilth, to provide plant nutrients and to prevent farmland weeds,

diseases and insect pests. This form of agricultural practice is usually termed organic agriculture or ecological agriculture. (Wen Dazhong, 1985). Despite the great logic of this view, given the current level of research and practice, this kind of organic or ecological agriculture cannot compete economically with petroleum intensive agriculture.

2. Development of Ecological Agrotechniques

In light of the situation described above, we can see that if the tremendous role of petroleum intensive agriculture in the development of China's agriculture cannot be completely replaced for a substantial period of time, the problems that its development occasions also have to be faced squarely. We should be guided by the aforementioned "reform" view to give serious attention to the feasibility and the practicality of solving problems that exist in petroleum intensive agriculture, and we should also take into consideration the future direction of development, and prospects for these measures. We should realize that the level of development of ecological agriculture or organic agriculture in European and American countries is still unable to match the economic benefits derived from petroleum intensive agriculture. We should also pay attention to the sensibleness of the philosophical thought that underlies ecological agriculture, as well as the fact that biological processes in intensive agricultural production may show enormous potential in future agriculture. We should also recognize the current dependence of agriculture on mineral energy resources represented by petroleum, and we should think about a way out for agriculture when petroleum energy resources dry up in the foreseeable future. Though there is copious biological and ecological data on numerous techniques that derive from the two views for surmounting the problems that exist in petroleum intensive agriculture, in actual practice, they exhibit uneven ecological and economic results. We should assimilate these advantages without exception, fully developing these agricultural techniques (or ecological agrotechniques) that have grown out of desire to attain certain ecological goals but that also produce marked ecological and economic benefits. We should assimilate and develop them, and use them to improve the current state of petroleum intensive agriculture and to develop the country's future agriculture.

Obviously, the ecological agrotechniques discussed here do not mean the same thing as ecological agriculture or organic agriculture, but rather mean a series of agricultural techniques or technical systems possessed of specific ecological significance. Such ecological agrotechniques or technical systems will become an important integral part of the total technical system of China's prevailing agriculture, and will function to improve China's present petroleum intensive agriculture, providing rich technical practice and experience.

3. The Important Types of Ecological Agrotechniques

The diverse ecological agrotechniques may be classified from various angles. In this article, only a rough classification will be made based on demonstrated technical results and technical characteristics possessed in accordance with ecological principles.

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(1) Ecological agrotechniques may be divided into several categories on the basis of ecological principles as follows:

(a) A series of ecological agrotechniques that have developed from effective utilization in time and in space of the rational structure of all biological varieties in the ecosystem, with fullest use made of resources principles (or ecological niche principles). Examples include intercropping, mixed cropping, companion cropping and crop rotation techniques, and agriculture and forestry techniques such as interplanting of forests and farm crops, rubber trees and tea plants...

(b) A series of ecological agrotechniques that have developed out of the coordination of multiple components within the ecosystem and promotion of the principles of symbiosis, as well as the principles of a balance in the interaction among multiple components. Examples include techniques for rearing fish in paddy fields, the interplanting of tung oil trees with grain, the use of bacteria to control insects and the use of some insects to control others.

(c) A series of ecological agrotechniques that have grown out of the transformation of matter and energy at many stages and at many levels in the ecosystem. Examples include fish pond techniques based on the growing of silkworm mulberry, multiple techniques for the utilization of agricultural byproducts, foremost of which is fermentation to produce methane gas, and another multiple technique for the utilization of agricultural byproducts, namely the growing of edible bacteria...

(2) The technical characteristics of ecological agrotechniques may be generally summarized under the following two headings in terms of ecological agrotechniques:

(a) Techniques for using soils in the agricultural ecosystem such as the building of a rational mix of farming, forestry and animal husbandry, of skills within farming, farming and forestry skills, and silkworm mulberry and fishpond techniques.

(b) Managerial and operating skills for the agricultural ecosystem such as managerial and operating skills for interlinked farming, breeding, and processing industries, skills for the management of farmland fertility, skills in the overall prevention and control of diseases and insect pests.

(3) Ecological agrotechniques may be categorized as follows in terms of the direct goals of ecological agrotechniques and the main technical results gained in application:

(a) Techniques for the conservation of soil and water.
(b) Techniques for nurturing soil fertility.
(c) Techniques for the prevention and control of diseases, insect pests, and weeds.
(d) Techniques for making multiple use of and for processing agricultural byproducts and refuse.

(e) Techniques for improvement of the microclimate and for protection of the agricultural environment.

(f) Rural energy techniques, etc.

It should be noted that most ecological agrotechniques are usually not singular in terms of the ecological principles on which they are based, their technical characteristics, or the technical results achieved; therefore, it is possible to classify various ecological agrotechniques only in terms of their outstanding features.

Obviously, of the multitude available, only those agricultural techniques that are able to bolster the maintenance and stability of the agricultural ecosystem in actual use (through either the application of single techniques or a combination of several techniques), or the techniques or body of techniques that show definite economic results may be regarded as ecological agrotechniques or a body of techniques.

Some of the many and varied ecological agrotechniques have been widely used in traditional agriculture, while others have developed as modern agriculture as developed. Still others have derived from modern biological techniques and other techniques, some of them demonstrating remarkable results when used alone in modern conventional agriculture. However, the combination and matching, in a rational way, of various ecological agrotechniques as specific circumstances warrant to form an optimum ecological agrotechnical system, and making it an important integral part of the conventional agricultural technical system will produce better results. Therefore, the building of an optimum ecological agrotechnical system as conditions warrant (natural, social and economic conditions in agriculture) should be a main emphasis in current research and practice.

4. Development of China's Ecological Agrotechniques in Recent Years

The building of China's agricultural ecology has been given redoubled attention in recent years, and numerous classic ecological agrotechnical system models of varying scale that employ ecological agrotechniques and that are founded on different natural and socio-economic conditions have appeared. These classic units and classic models have the following general characteristics:

(1) Improvement of the ecological environment as a premise and improvement of economic and social results as their direct goal, ecological, economic, and social effects being closely linked.

(2) Attention to the overall application of ecological agrotechniques, carrying out a readjustment and a rational patterning of the regional make-up of farming, forestry, and animal husbandry to bring overall agricultural production more in line with ecological laws and economic laws.

(3) All around application of all ecological agrotechniques as conditions warrant to build an optimum ecological agrotechnical system.

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(4) Attention to the development of land utilization techniques, particular attention going to the building within identical land units of various kinds of three dimensional agricultural ecostructures that use the environment and resources in multiple ways.

(5) Attention to the use of an ecological agrotechnical system combining the farming industry, the breeding industry and processing industries for agricultural and agricultural byproducts, thereby using agricultural products and byproducts at various levels and in various ways to achieve multiple economic and ecological benefits in increasing output and increasing value while eliminating pollution.

(6) Ecological agrotechniques centering around little or no plowing are in process of being popularized and promoted in farm crop production.

5. Two Present Tendencies That Should Arouse Serious Attention

As was said above, many of the resources, environmental and ecological problems that accompany and are brought about by petroleum intensive agriculture are related to the large scale use of chemical fertilizers and pesticides. Though we are all for the role of chemical fertilizers and pesticides in the development of modern agriculture, and do not advocate the adoption of "complete abandonment or virtually no use of chemical fertilizers and pesticides" to solve this problem; nevertheless, development and use of various ecological agrotechniques that have as their main goal a reduction in the use of chemical fertilizers and pesticides should remain the main focus in reform of the existing petroleum intensive agriculture. There are two present tendencies that should be given attention to effect a turn around.

(1) Turn around in farm crop production of the tendency to neglect various ecological agrotechniques to nurture soil fertility and to control damage from diseases, insect pests and weeds.

Use of agricultural waste products such as organic fertilizer, and crop rotation that alternates the growing of non-pulse crops with pulse crops or green manure crops, and the use of various forms of intercropping, mixed cropping, and companion cropping, as well as other ecological agrotechniques are effective measures for the maintenance of soil fertility and control of the damage caused by diseases, insect pests and weeds that have been used in China's traditional agriculture. They are also an important foundation for maintaining and stabilizing the traditional agricultural ecosystem. Clearly, these techniques can continue to function in maintaining the ecology in modern agriculture, and in improving the country's present petroleum intensive agriculture. However, these ecological agrotechniques are more and more neglected for various economic, technical and managerial reasons. A survey conducted in Henan Province (Lu Wen [4151 2429], 1986) showed a 20 percent decrease over the same period in the previous year in the area planted to green manure in the spring of 1985, and a 34 percent decline over the previous year in the spring application of farmyard manure. In numerous cities, manure is no longer used. A survey conducted in five counties of Jinzhou City in Liaoning Province (Yang Guorui [2799 0948 3843], 1986), showed that 11.6 percent of the

cultivated land in 23 percent of peasant households received no farmyard
manure in the spring of 1986. In 32 percent of peasant households, i.e., on
33 percent of the cultivated land, only between 1 and 2 cartloads of mud
fertilizer were applied to each mu of land. In addition, during the 4 years
since the advent of contracting linked to output, some peasant households have
applied no manure whatever to the fields. In 1984, the area sown to soybeans
in Jilin Province was 32 percent smaller than in 1979, the area sown to soy-
beans in 1984 amounting to only 10.6 percent of the grain crop area. Mean-
while, the area sown to corn has increased 16 percent in 5 years. In 1984,
the corn growing area stood at 53 percent of the grain growing area. Even
though widespread publicity has been given in recent years to various eco-
logical agrotechniques that can be applied, the ability of the agricultural
ecosystem to regulate itself, and its stability has become increasingly weak,
and it has come to depend increasingly on inputs of petroleum energy in the
form of chemical fertilizers and pesticides.

Despite the emphasis many people have placed in discussion of problems per-
taining to the agricultural ecology on increasing the elementary productivity
of green plants as an important ingredient in the betterment of the agricul-
tural ecology, few pointers have been given on just how to use ecological
agrotechniques to improve green plants' (particularly farm crops') elementary
productivity. One must realize that, virtually without exception, increase
in the elementary productivity of plants is the most basic goal in any kind
of agriculture. The question is what methods to take to raise it. If such
an increase is simply to continue large inputs of chemical fertilizers and
pesticides, the result will be movement toward just the reverse of ecological
agriculture.

2. In making multiple use of agricultural products and their byproducts,
there is a tendency to pursue "numerous links" and "long chains."

As was said earlier, the pattern of material and energy flow through the food
chain in the ecosystem of recent years has given rise to a series of forms
for the multi-stage and multi-level use of agricultural products and their
byproducts. Though many of these forms have been successful and provide
marked economic and ecological benefits, many of them are only a pursuit of
"numerous links" and "long chains" for their own sake. In reality, they lack
an ample experimental basis and they also lack real feasibility. The results
shown in Figure 1 provide inspiration. This is a material flow chart that
uses the element nitrogen to show a multi-stage, multi-level utilization
system for agricultural products and byproducts that the author drew on the
basis of the results of a very interesting experiment performed by Sun Yufang
[1327 3768 5364].[1] The chart uses relative percentage values for the bio-
logical energy and total amount of nitrogen contained in straw raw material,
which are expressed in terms of individual amounts of biological energy and
amounts of nitrogen in each link in the food chain. This appears to be a
very ordinary example of the multiple use of agricultural byproducts; never-
theless, we can clearly read the following points from it:

(1) The proportion of energy and nutrient material content in the product at each stage in the nutritional process is very slight. Most of the material energy and nutrient material is not transformed into product but remains in waste; or it is lost in the form of heat or gas. In the natural ecosystem, the stage-by-stage correlation in the food chain of predators and the preyed upon follows a "10 percent law." This is to say that the energy conversion rate between one nutritional stage and another is approximately 10 percent. Despite the difference between the situation under artificially controlled conditions and the natural ecological system, the tendency toward no transformation of most energy and nutrients is immutable. Thus, the longer the chain, the greater the loss of materials and energy. Obviously the production system for such a food chain is not simple production "without waste;" rather, the "utilization of waste" to produce energy and nutrients is accompanied by great losses.
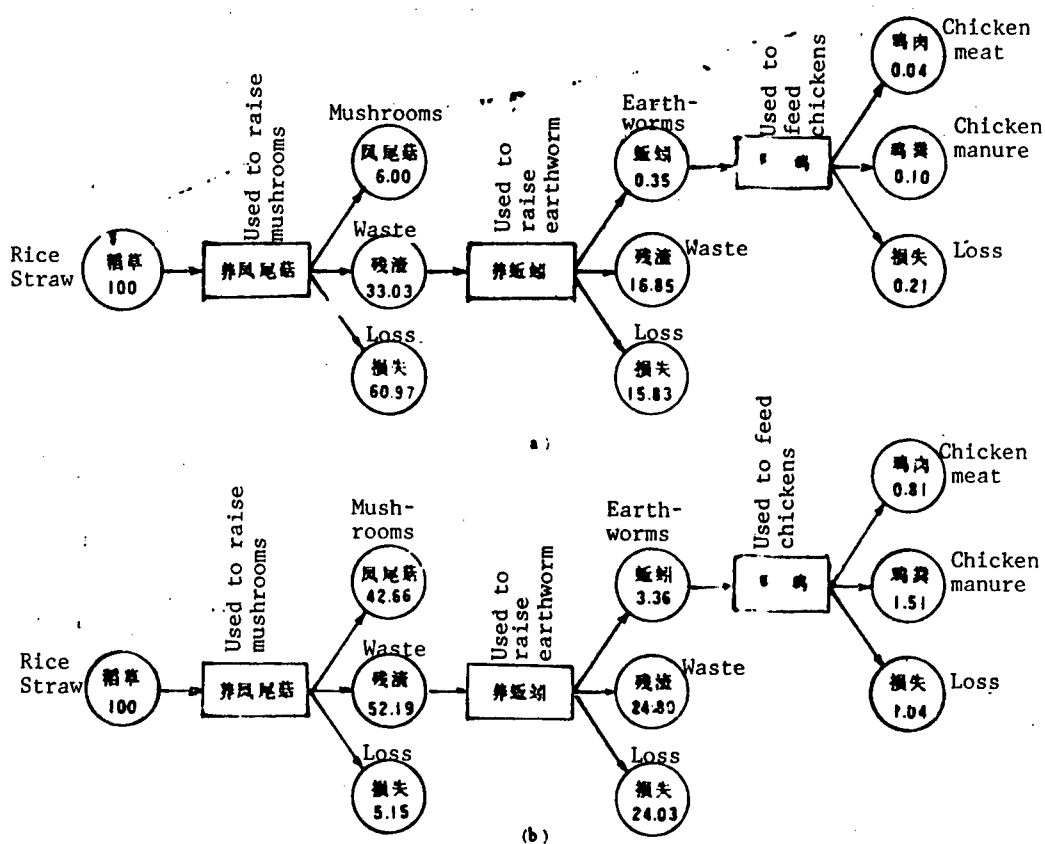

Figure 1. Energy and Nitrogen Nutrient Flow in a Multi-Level Production System From Rice Straw to Mushrooms to Earthworms to Chickens. The Numbers Shown Are Percentages of Rice Straw, the Value of Which is 100 Percent

(2) Application of proper techniques to control the length of the nutrition chain can yield marked economic and ecological benefits. In this example in which rice straw is used to raise mushrooms, 42.66 percent of the nitrogen content of the rice straw is used by the mushrooms, only 5.15 percent of the nitrogen being lost. A large amount of nitrogen remains in the waste. Consequently this nutritional link not only increases the economic value of the rice straw, it also conserves and uses a large amount of the nutrient material. If the waste from the raising of the mushrooms is further used to raise earthworms, and the earthworms are used to feed chickens, only 1.55 percent of the nitrogen in the mushroom waste is transformed into the final chicken product and nearly half the nitrogen nutrient is lost. On this basis, the economic benefit derived from using the mushroom waste to raise earthworms for feeding to chickens is much less than from returning the mushroom waste to the fields as fertilizer to replace chemical fertilizer, or use of the mushroom waste directly as fuel.

China's rural villages suffer from a severe shortage of energy for use in daily life. As a result, they have no choice but to use as fuel large amounts of organic material from agriculture that would otherwise by returned to fields as fertilizer. If the tendency to pursue "numerous links" and "long chains" in the multiple use of agricultural byproducts increases, the already very serious shortage of organic matter in agriculture will become even more serious as a result of the loss of large amounts of it in growing processes. Objectively, this will make the country's agricultural ecosystem more "petroleum intensive" and "less organic."

Improvement of the country's petroleum-intensive agriculture, particularly a reversal of the aforementioned two tendencies that deserve attention, will require efforts in many regards. However, doing a better job of research and development of ecological agrotechniques is of crucial importance. This includes increased scientific critiques and improvement of practice in the use of ecological agrotechniques. Study and exploration of modern ecological principles can provide a series of traditional ecological agrotechniques for reference and application to modern agriculture, and can bolster research of a basic nature on ecological agrotechniques for the agricultural ecology and for the economics of technology. In addition, attention should also be given to doing a good job of publicizing and popularizing information about the modern ecology and the agricultural ecology.

(Draft Accepted 16 January 1987)

1. Sun Yufang: Study of the Ecological Functioning of the "Rice Straw-Mushrooms-Earthworms-Eating Chicken" Food Chain, Masters Degree Thesis at Shenyang Agricultural University, 1985.

About the author: Wen Dazhong is a 46 year old male who graduated in 1964 from the Institute of Forestry and Soil Science, Chinese Academy of Sciences as an assistant research fellow. He is currently serving as deputy director of the Farmland Ecology Institute of the Institute of Forestry and Soil Science where is is responsible primarily for research on the agricultural ecology and the forestry ecology. His current major research orientation is toward agro-ecological energetics or energy flow in the agricultural ecological system, as

well as the functioning of the agro-ecological system and ecological agriculture. From 1982 through 1984, he worked at Cornell University in the United States with Professor D. Pimentel, conducting research on some of the agro-ecological systems of China during different periods. He has produced a total of 50 independently published or jointly published papers, monographs, and translations. Some of his papers have been published in foreign academic journals and monographs.

9432/7358

PRELIMINARY DISCUSSION OF ECOLOGICAL AGRICULTURE DEVELOPMENT

[English abstract of article by Han Chunru [7281 4783 0320] of Beijing
Agricultural University]

[Text] Building modern agriculture on an ecologically sound basis has been
scheduled for public attention in the world's agricultural development.
Recently there have been rapid advances in organic farming and biological
agriculture, emphasizing theoretically organic and biological methods
excluding chemicals. It has been noted, however, that organic and chemical
input can often be integrated in practice with the application of manure,
crop rotation, conservation tillage, etc., as major components of the agro-
technology system. The ecological agriculture proposed and extended in China,
in accordance with the historical experience and specific conditions of the
country, is an objective necessity for managing agricultural production
through systematic thinking and from an ecological viewpoint. Ecological
agriculture is defined as a farming system of sound ecological circulation,
developed according to ecological theories and principles of ecological
economics. It pertains to the design and management alternatives oriented to
different levels of the ecosystem, the technology of which includes at
present the rational exploitation of resources found in rural land, a system
of coexistence, circulation of organic materials, a system of plant cultiva-
tion-animal production-product processing, and the environmental management
of rural areas. The ecological agriculture is a strategy for the development
of rural production, focusing on the unity of resource exploitation and pro-
tection. It is necessary for ecological agriculture to build five principal
workshops in the system: the cropland, non-cropland, human, livestock and
processing workshops. The optimization of the input and output and the
continual improvement of the system whould be achieved by network controlling
of the fluxes of energy, matter, information and money within the system and
between the system and its environment. Major efforts in building ecological
agriculture should be directed toward fundamental primary production, product
transformation in order to increase its market value, developing potential
productivity of the system, collecting information, intensifying modern pro-
ductive input and application of biological/organic measures. A successful
development of ecological agriculture in China would make a great contribution
toward China's future itself and that of the world as a whole.

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STATUS OF ANIMAL QUARANTINE STANDARDIZATION EXAMINED

40081073 Beijing ZHONGGUO BIAOZHUNHUA [CHINA STANDARDIZATION] in Chinese
No 11, 5 Nov 86 pp 3-5

[Article by Chen Hua [7115 5478] of the Jilin Agricultural University]

[Text] Efforts to achieve agricultural standardization in our country are
still weak. Animal quarantine standardization is a component of the
standardization of animal husbandry. We would now like to discuss some
opinions and suggestions in regard to work in animal quarantine standardization.

I. The Importance of Developing Animal Quarantine Standardization

Animal quarantine standardization is that part of the animal quarantine work
that deals with the establishment of standards for names of diseases, the
quarantine process and treatment procedures for diagnosed infectious diseases.
It also deals with guaranteeing the enforcement of these standards, so that
maximum economic and social benefits can be obtained. This discipline is of
great importance.

1. It helps to prevent the invasion of foreign infectious diseases, protects
and develops animal resources in our country, and also effectively prevents,
controls and eradicates the spread of various infectious diseases introduced
from foreign countries.

2. It guarantees the health and safety of the population, and protects
consumer rights. Nowadays, trade in both urban and rural areas is developing
very quickly. However, because animal quarantine standardization has not
caught up, a fair number of problems have cropped up in these avenues of
trade. In 1984, the purchase and ingestion of dead livestock from butchers
resulted in the serious incidence of 488 food poisoning cases and 2 deaths
in Xushui County, Hebei Province. Developing quality animal quarantine
standardization can contribute to the scientific basis for eradicating animal
infectious diseases. At the same time, it helps in the prevention of food
poisoning from animal sources and the spread of diseases in humans and
animals.

3. In foreign trade, animal quarantine standardization can enhance the
mutual understanding and economic benefits of the trading partners. As trade

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develops in our country, the import and export of animals and animal products have multiplied in recent years. For example, Shuangliao County signed contracts to export 1,000 cows and 1,500 tons of beef this year. However, because our country's animal quarantine standards were not trusted, the animals had to be shipped to Shenzhen for quarantine by foreign merchants, thus resulting in economic loss.

Some people consider the eradication of infectious diseases in livestock as an important measure of a country's success in animal disease prevention and quarantine. In the last 40 years, our country has not only eradicated the fewest animal infectious diseases, it has also allowed the spread of infectious diseases not previously existing. This indicates that animal quarantine standardization needs further research and development.

II. The Main Content of Animal Quarantine Standardization

1. The standardization of names of quarantine diseases represents a kind of standard technical vocabulary. GB 3935.1-83 stipulates the use of standardized names for diseases, definitions (or explanatory description) and corresponding names in foreign languages. This is the basis of standardization. When there are standardized names of diseases, then standards for corresponding quarantine process can be researched and established. This will also help in the thorough enforcement of these standards.

For quarantine work at ports of entry, we have established "List of animal import quarantine items for the People's Republic of China," taking into consideration the current conditions in regard to animal infectious diseases within China and overseas, totaling 74 diseases. In addition to diseases for which quarantine is required by the country, provinces, (cities) and regions can append diseases for which quarantine is required according to the local situation.

2. GB 3935.1-83 points out that the animal quarantine process is a standard requirement for specifying the technological requirements of animal quarantine and the actual procedures involved. It is a form of standardization. Establishing actual quarantine processes is an important part of animal quarantine standardization. By revising standards, using advanced technology and research results in veterinary science to improve the animal quarantine process in a timely fashion, and by ensuring that quarantine work is accurate, fast, economical, and self-sustaining, the quarantine process will be guaranteed to be both practical and scientific. The process of animal quarantine usually includes sample standardization and quarantine procedures.

(1) Sample standardization. For bulk quarantine cases, random sampling is usually required. This is both economical and time-saving. It also speeds up final quarantine reporting and guarantees the quality and accuracy of the results.

(2) Quarantine procedure standardization. Quarantine standardization is form of methods standardization. GB 3935.1-83 points out that methods

standardization means the use of testing, study, analysis, sampling, statistics, calculation, application and other methods as ways to establish standards. There are many quarantine procedures. Some diseases require a combination of many methods. Some only need one or two methods. Therefore, different quarantine procedure standards have to be established for different diseases.

III. Current Status of Animal Quarantine Work in Our Country

1. Establishment of standards.

(1) In 1959, the State Council delegated authority to the Ministry of Agriculture, in conjunction with the Ministries of Public Health, Commerce, and Foreign Economic Relations and Trade, to establish a "health quarantine process for meat products." This was a national veterinary health testing trial procedure, and it also represents an important basis for standards used in animal quarantine work up to the present.

(2) In June 1982, the State Council issued the "People's Republic of China animal and plant quarantine regulations," pointing out that "the importation of animals and animal products and the vehicles for such transportation into the People's Republic of China for commercial and noncommercial purposes are subject to quarantine."

(3) In February 1985, the State Council issued "livestock and fowl disease prevention regulations," further emphasizing that animal products (raw and uncooked meat, lard, organs, skin, blood, hair, bone, hoof, horn, seminal fluid, fertilized egg) must meet stringent quarantine standards. In April of the same year, the Ministry of Agriculture, Animal Husbandry and Fisheries issued details of this regulation. The entire country and its provinces (cities), and regions must follow this regulation and consider the local situation in establishing local standards, so that animal quarantine work may change drastically. For example, in Liaoning Province, the following procedures were established for implementation in 1986: "market quarantine methods," "transport quarantine methods," "fowl quarantine methods," and "individual veterinarian quarantine methods." This step has already been taken in Jilin Province.

2. Enforcement of standards.

(1) The State Council authorized the establishment of animal and plant quarantine institutes (stations) at ports of entry. There are 36 ports of entry in the entire country, distributed among important ports and border cities such as Tianjin, Qinhuangdao, and Shenzhen.

In 1955, the State Council designated our country's united meat processing plants, egg product plants, and butchering plants to be under the leadership of the Chinese Food Product Company of the Ministry of Commerce. It also required that the Chinese Food Product Company, under the supervision of the Ministries of Agriculture and Public Health and the State Council, organize the quarantine work in regard to meat and egg products of our country. In recent years, many areas have established various levels of animal quarantine

units, most of them under the supervision of the Ministry of Agriculture, Animal Husbandry and Fisheries.

(2) Large-scale quarantine work at these sites was conducted using a national level of organization and leadership. For example, horses numbering in tens of millions were examined in a national study of an infectious disease of horses.

Our country has allocated large sums of money for the eradication of disease in livestock.

Our country has trained a large number of quarantine personnel, and popularized a great deal of experience in technological advances. After many years of work, our nation eradicated cattle plague in the fifties. Over 10 infectious diseases are effectively under control. Work on controlling other infectious diseases has also made progress.

The Ministry of Agriculture, Animal Husbandry, and Fishery has also emphasized combined veterinarian defense efforts in large regions. In the large regions of Huabei, Dongbei, Xibei, and Huadong, veterinary units in the provinces (cities) and regions have united to take part in quarantine procedures, and this has resulted in fairly good control of diseases.

Our country has strengthened combined veterinarian quarantine work on our country's railroad system. The major emphasis is on the prevention of the spread of infectious diseases via railroad transport of animals and animal products.

In 1979 the Ministry of Public Health and the Industry and Commerce Central Bureau issued a joint promulgation on "trial procedures for sanitary management of village commercial food products." In October 1985, the Ministries of Commerce, Agriculture, Animal Husbandry and Fisheries and Public Health and the Industry and Commerce Central Bureau jointly issued a "Notice on work on the strengthening quarantine of livestock and meat products."

Although our country has already emphasized animal quarantine work, it still needs to improve and develop work in this area.

IV. A Few Suggestions on Our Country's Animal Quarantine Work

1. The establishment and revision of animal quarantine standards should be speeded up.

According to the "People's Republic of China standardization administration regulation," standards must be reviewed every 3 to 5 years. "Meat products sanitary inspection trial procedures" is the main standard for current animal quarantine work. It has been 26 years since the establishment of these standards in November 1959. Since that time, animal quarantine has gone through major changes. Not only are quarantine processes for specific

diseases unscientific, but for some diseases such as swine dysentery and scrapie these are no quarantine processes even though these diseases are widespread throughout the world. Timely establishement of reasonable supplementary regulations for these diseases is suggested.

2. The thorough enforcement of animal quarantine standards should be strengthened.

First, the establishment of quarantine units should be enhanced and their quality improved. To do this we must establish stringent policies on evaluation techniques and quarantine supervision. We should also fully utilize agricultural instructional personnel and facilities at or above the current technical institute level to provide rotational in-service training and advanced studies for existing personnel.

Second, a comprehensive animal quarantine system should be provided, encompassing the regulatory characteristics of animal quarantine standardization. Leadership at all levels must emphasize animal quarantine work. A comprehensive system of animal quarantine must be established quickly involving provinces, cities, counties, and villages. It is also important to assert the authority of animal quarantine personnel, and in collaboration with authorities in health, industry and business, animal husbandry, and public safety, so as to fully develop the regulatory characteristics of animal quarantine standardization.

Third, advanced quarantine equipment should be prepared and the level of animal quarantine elevated. Methods of quarantine must be more microscopic, efficient, and self-sustaining. Advanced technologies such as immuno-enzymology, electron microscope, and monoclonal antibodies must be actively incorporated. According to the distribution of animals, within regions a predetermined level of veterinarian units, a veterinarian hospital and clinical laboratories with adequate research facilities must be established. At the same time, research results from veterinary sciences must be actively applied in animal quarantine standardization work. Advanced international and foreign standards must be actively incorporated in order to elevate the level of animal quarantine standardization in our country. For example, we should refer to WHO/BS83.1407: standards in biological terms; ISO/SC9: standardization in microbiological analysis; and various standards published by the Food and Agriculture Organization (FAO/WHO).

12996/9835

TECHNICAL ADVANCES SPUR CARBON BLACK PRODUCTION

40082110a Beijing GUANGMING RIBAO in Chinese 30 Mar 87 p 1

[Article by Dong Kegong [5516 0344 1872] And Wang Zhe [3076 0772]: "With Solid Research Work as a Basis, Oriented Toward Economic Construction Flexible Service; Ministry of Chemical Industry's Carbon Black Institute Gradually Becomes an Industrial Technology Development Center; In Any Aspects of Carbon Black Production, It Carries Out Research and in the Past Few Years Has Completed 95 Scientific Research and Design Tasks To Provide Experience for the Reform of Science and Technology of Industrial Institutes"]

[Text] On the basis of solid research work, the Carbon Black Institute of the Ministry of Chemical Industry has adopted a variety of flexible forms of service and has earned a reputation in the carbon black industry, gaining prestige, and is gradually becoming the technology development center of China's carbon black industry and providing valuable experience for reform of the science and technology system of China's industrial institutes.

The Carbon Black Institute has not only undertaken basic work in carbon black industry standardized formulations and quality control, but more prominently has undertaken work in research and development of new varieties, new processes and new equipment, promoting results and digesting and absorbing imported items. Most of China's carbon black industry now has adopted the results of its science and technology in a variety of forms.

The Carbon Black Institute has learned from experience that the formation of an industrial technology development center is a good means of establishing the industry's production on the basis of technological advance. But it does not rely on orders of proclamations from upper echelons. Rather, it must have a solid scientific research work foundation and a variety of forms of service in alliance with the industry's production and correct service attitude.

For the past few years, proceeding from using the raw materials produced by the carbon black industry for developing new products, in any aspect of carbon black production, the Carbon Black Institute carried out research and obtained abundant results. In the past few years, the institute has completed 95 scientific research and design tasks, of which 52 were scientific research projects and 43 were design projects. The carbon black used for vehicle paint and the high-structure medium-to-super abrasion-resistant carbon black

developed by the institute have won national scientific society prizes, while the carbon black, superconducting carbon black, new industrial carbon black and wet granule creation using ethylene tar as a raw material have won ministry-level and provincial prizes. The accomplishments, including new industrial carbon black, carbon black produced from ethylene tar as a raw material, generation of electricity using carbon black tail gas, and high-structure medium-to-super abrasion-resistant carbon black, have been spread over a large area of the carbon black industry and have produced enormous economic benefits. In a half year of putting new industrial carbon black technology into production, Anshan Chemical Industry No 2 Plant earned 1.7 million yuan in profits, recovering its investment in the same year and earning over 3 million yuan in the next year. The Sichuan Yongchuan Chemical Industry Plant used the results of this project and leaped from a loss unit to a profit enterprise and now earns over 2 million yuan per year. According to preliminary statistics, enterprises now using this result can increase state profits over 10 million yuan per year. In addition to finding and using electricity for production within the plant, enterprises using carbon black tail gas to generate electricity also have a considerable surplus. The economic benefits produced by the Carbon Black Institute's scientific research have resulted in enormous attraction to and cohesiveness within the carbon black industry. How can this force grow and prosper? The institute throughout has concentrated on dealing with the relationship between current goals and long-range goals, and while promoting its own results has constantly developed new technologies and new processes. Since last year, it has been carrying on research on such reserve technologies as soft new industrial carbon black, pigment carbon black, and special types of carbon black, and has obtained some preliminary results.

Having only technological strength is not enough; experience has demonstrated to the Carbon Black Institute that it is necessary to change a scientific research and production system that is disjointed. For the past few years it has used five methods to take science and technology work into enterprises. The first is to use such means as the results of its own research, engineering design, physical and chemical testing, and research devices to serve the development of carbon black enterprise technology; the second is to combine its own research projects and the production development plans of a plant by means of cooperation; the third is by means of technical shareholding to conclude long-term contracts and jointly plan and manage the economic development of the enterprise; the fourth is to undertake the digestion and absorption of items imported by the enterprise; and the fifth is to enter into industrial type technological association and participate in technological cooperation. While using these methods, it has throughout firmly upheld placing the emphasis on the enterprise's own construction first of all. In relations with enterprises, it thinks about what the enterprise thinks about, it is concerned about what concerns the enterprise, it places the customer first and quality first; in terms of charges, it seeks small profits and rapid turnover; and the forms of service are many and varied. It does not matter to the institute whether the foreign technology that some enterprise wants to import or has already imported is technology that is developing itself or has already developed; it is ready to give advice to the

enterprise in order to help it digest and absorb the imported technology. While transferring the results of its research to enterprises, the institute pays close attention to the capacity of the market in making proper arrangements. It would rather obtain less in transfer fees than to create disorder in a new area and duplicate production, causing a loss for the country. The variety of forms of service to enterprises and the correct service attitude leads to a close relationship with enterprises.

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TWO-YEAR FIGURES GIVEN ON PATENT APPLICATIONS

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[Article by Li Fuying [2621 1381 5391]: "Second Anniversary Of China's Patent Law; Invention and Creation Patent Applications Continue To Increase; the China Patent Office Has Received Over 37,000 Applications for Patents From China and Abroad in 2 Years"]

[Text] Today is the second anniversary of the implementation of China's patent law. In this period, China's patent workers have actively implemented the party's direction, policies, and line; upheld reform; and struggled hard to make a contribution to developing patent work, to stimulating the economy and to developing science and technology. This is clear from the number of patent applications received in the past 2 years.

From 1 April of last year to 21 March of this year, the applications received by the China Patent Office are as follows: 37,436 applications for inventions and creations from China and abroad have been received and processed, including 18,075 applications for patents on inventions, 17,676 applications for patents on the use of new models, and 1,685 applications for patents on external design, comprising 48.2 percent, 47.3 percent and 4.5 percent of the total number of applications, respectively. The number of domestic applications comes to 26,792 and foreign applications to 10,644 foreign applications, accounting for 71.6 percent and 28.4 percent of the total number of applications, respectively. There were 19,853 applications for patents on duty inventions and creations and 17,583 applications for nonduty inventions and creations, accounting for 53 percent and 47 percent of the total number of applications, respectively.

At present, the number of applications for patents on inventions and creations are continuing to increase. The number of applications last year increased nearly 30 percent over that of the year before; the number of applications increased 33 percent in the first quarter of this year compared to the same period last year; domestic applications have increased while foreign applications tend to have stabilized. The volume for the three types of current patent applications are as follows: patents for inventions have decreased slightly; external design patents have increased slightly; applications for patents on the use of new models have increased sharply, i.e., up to 52.2 percent last year from 36 percent of the previous year's

total volume of applications. Comparing applications for patents on duty invention and creations with those on nonduty inventions and creations, more applications have been received for domestic nonduty patent applications than for duty patent applications, but it is the reverse for foreign patent applications.

This situation shows that strengthening the patent work of some units is an important task at present.

In terms of regional patent applications, the five leading domestic patent application areas are: Beijing, 3,684; Jiangsu, 2,056; Shanghai, 1,974; Liaoning, 1,961; and Hunan, 1,829; the five leading foreign countries are: Japan, 3,XX4 [figure partly illegible]; United States, 3,009; Federal Republic of Germany, 1,006; England, 486; and the Netherlands, 463.

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MATHEMATICAL STRESS ANALYSIS OF COMPOSITE MATERIALS

[Article by Zhang Shuangyin [1728 7175 1377] of Beijing Institute of Mechanics, Chinese Academy of Sciences and C.M. Leech of the Department of Mechanical Engineering, School of Science and Engineering, Manchester University, England. Manuscript received 28 Dec 85, revised 14 Oct 86: "Non-uniform Iso-parametric Element for Stress Analysis of Composite Materials"]

[Text] Abstract: This paper introduces the concept of non-uniform iso-parametric element and derives the corresponding rigidity matrix. As an application, the stress distribution at the end of a composite rope is calculated based on an axisymmetric non-uniform element method.

I. Introduction

A composite material is composed of two or more materials of different properties. It is anisotropic and heterogeneous. At the present moment, all finite element methods used for composite materials are homogeneous elements, which assumes that the material is homogeneous and isotropic in the entire element. The effect of inhomogeneity is omitted. When this type of a finite element scheme is used to analyze the stress on a composite material, the result is the average of the stress on the matrix and the reinforcing material. When the distribution of the reinforcing material is sparse and there is a large difference in modulus, such as in reinforced concrete, the stress value derived from a uniform element method is very inaccurate. To use this analysis to predict the strength of the material will result in very serious error.

In order to overcome this deficiency, this paper introduces the non-uniform element concept. The property of material in an element may be different. In some areas (such as areas with reinforcing materials), it has the properties of the reinforcing material. In other areas, it has the characteristics of the matrix. Based on the pseudo-work principle, the non-uniform iso-paramatric element is created by using the Gauss integration technique on the basic equation for uniform finite element to derive the non-uniform finite element rigidity matrix. As an example, the stress distribution at the end of a composite rope frustum is calculated. The result shows that this

non-uniform finite element method is very effective in analyzing the composite materials of sparse fibers (or rebars).

II. Structure of Non-uniform Iso-parametric Element

1. Basic Equation

The non-uniform element rigidity matrix is based on the following pseudo-work principle:

$$\int_{Q} [\delta\varepsilon]^T \sigma d\Omega - \int_{Q} [\delta\tilde{u}]^T b d\Omega - \int_{\Gamma_t} [\delta\tilde{u}]^T \tilde{t} d\Gamma = 0, \tag{1}$$

where b is the volume force vector, $\tilde{t}$ is the surface force vector, $\delta\tilde{u}$ is the pseudo-displacement vector, $\delta\varepsilon$ is the pseudo-strain vector, σ is the stress vector, Γ_t is the boundary with boundary force, Q is the volume of the elastic body and the superscript T indicates the transport of the corresponding matrix.

The first term in equation (1) is the strain energy of the elastic body. The unit rigidity matrix is derived from this term. The following is a list of the basic equations used in the derivation of the non-uniform element rigidity matrix:

The element displacement vector is:

$$\tilde{u}^{(e)} = \sum_{i=1}^{k} N_i^{(e)} d_i^{(e)}, \tag{2a}$$

The element pseudo-displacement vector is:

$$\delta\tilde{u}^{(e)} = \sum_{i=1}^{k} N_i^{(e)} \delta d_i^{(e)}, \tag{2b}$$

where $d_i^{(e)}$ and $\delta d_i^{(e)}$ are the element node displacement and pseudo-displacement, respectively. $N_i^{(e)}$ is a shape function and its expression can be found in references [1,2]. k is the number of element nodes. The superscript (e) denotes an element.

The element strain vector is:

$$\varepsilon^{(e)} = \sum_{i=1}^{k} B_i^{(e)} d_i^{(e)}, \tag{3a}$$

The element pseudo-strain vector is:

$$\delta\varepsilon^{(e)} = \sum_{i=1}^{k} B_i^{(e)} \delta d_i^{(e)}, \tag{3b}$$

where $B_i^{(e)}$ is the element strain matrix.

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The element stress vector is:

$$\sigma^{(e)} = D^{(e)} \varepsilon^{(e)}, \tag{4}$$

where $D^{(e)}$ is the element elasticity matrix, or the element structure matrix.

Substitute equations (3) and (4) into the first term of equation (1), we get

$$\sum_i K_{ij}^{(e)} d_j^{(e)} = \int_{\Omega^{(e)}} [B_i^{(e)}]^T D^{(e)} \left(\sum_{j=1}^k B_j^{(e)} d_j^{(e)} \right) d\Omega, \tag{5}$$

where $\Omega^{(e)}$ is the element volume. The element node displacement $d_i^{(e)}$, is expressed differently in different types of questions.

In a planar problem:

$$d_i^{(e)} = [u_i^{(e)}, v_i^{(e)}]^T. \tag{6a}$$

In an axisymmetry problem:

$$d_i^{(e)} = [u_i^{(e)}, w_i^{(e)}]^T. \tag{6b}$$

In a three-dimensional problem:

$$d_i^{(e)} = [u_i^{(e)}, v_i^{(e)}, w_i^{(e)}]^T. \tag{6c}$$

The expression of the element strain matrix $B_i^{(e)}$ is:

In a planar strain or stress problem:

$$B_i^{(e)} = \begin{bmatrix} \left(\dfrac{\partial N_i}{\partial x} \right)^{(e)}, & 0 \\ 0, & \left(\dfrac{\partial N_i}{\partial y} \right)^{(e)} \\ \left(\dfrac{\partial N_i}{\partial y} \right)^{(e)}, & \left(\dfrac{\partial N_i}{\partial x} \right)^{(e)} \end{bmatrix}. \tag{7a}$$

In an axisymmetry problem:

$$B_i^{(e)} = \begin{bmatrix} \left(\dfrac{\partial N_i}{\partial r} \right)^{(e)}, & 0 \\ \left(\dfrac{N_i}{r} \right)^{(e)}, & 0 \\ 0, & \left(\dfrac{\partial N_i}{\partial z} \right)^{(e)} \\ \left(\dfrac{\partial N_i}{\partial z} \right)^{(e)}, & \left(\dfrac{\partial N_i}{\partial r} \right)^{(e)} \end{bmatrix}. \tag{7b}$$

In a three-dimensional problem:

$$
B_i^{(e)} = \begin{bmatrix}
\left(\dfrac{\partial N_i}{\partial x}\right)^{(e)}, & 0, & 0 \\[2mm]
0, & \left(\dfrac{\partial N_i}{\partial y}\right)^{(e)}, & 0 \\[2mm]
0, & 0, & \left(\dfrac{\partial N_i}{\partial z}\right)^{(e)} \\[2mm]
0, & \left(\dfrac{\partial N_i}{\partial z}\right)^{(e)}, & \left(\dfrac{\partial N_i}{\partial y}\right)^{(e)} \\[2mm]
\left(\dfrac{\partial N_i}{\partial z}\right)^{(e)}, & 0, & \left(\dfrac{\partial N_i}{\partial x}\right)^{(e)} \\[2mm]
\left(\dfrac{\partial N}{\partial y}\right)^{(e)}, & \left(\dfrac{\partial N_i}{\partial x}\right)^{(e)}, & 0
\end{bmatrix} .
\tag{7c}
$$

The differential element volume $dQ^{(e)}$ is expressed as:

In a planar stress problem:

$$
d\Omega^{(e)} = t \det J \, d\xi \, d\eta ,
\tag{8a}
$$

where t is the thickness.

In a planar strain problem:

$$
d\Omega^{(e)} = \det J \, d\xi \, d\eta .
\tag{8b}
$$

In an axisymmetry problem:

$$
d\Omega^{(e)} = 2\pi r \det J \, d\xi \, d\eta ,
\tag{8c}
$$

where r is the radius.

In a three-dimensional problem:

$$
d\Omega^{(e)} = \det J \, d\xi \, d\eta \, d\zeta ,
\tag{8d}
$$

where ξ, η and ζ are local coordinates of iso-parametric coordinate transformation. det J is the Jacobi determinant. The expression for the Jacobi matrix is:

In a planar problem:

$$
J = \begin{vmatrix}
\dfrac{\partial x}{\partial \xi}, & \dfrac{\partial y}{\partial \xi} \\[2mm]
\dfrac{\partial x}{\partial \eta}, & \dfrac{\partial y}{\partial \eta}
\end{vmatrix} ,
\tag{9a}
$$

in an axisymmetry problem:

$$J = \begin{vmatrix} \dfrac{\partial r}{\partial \xi}, & \dfrac{\partial z}{\partial \xi} \\[2mm] \dfrac{\partial r}{\partial \eta}, & \dfrac{\partial z}{\partial \eta} \end{vmatrix} \quad , \tag{9b}$$

in a three-dimensional problem:

$$J = \begin{vmatrix} \dfrac{\partial x}{\partial \xi}, & \dfrac{\partial y}{\partial \xi}, & \dfrac{\partial z}{\partial \xi} \\[2mm] \dfrac{\partial x}{\partial \eta}, & \dfrac{\partial y}{\partial \eta}, & \dfrac{\partial z}{\partial \eta} \\[2mm] \dfrac{\partial x}{\partial \zeta}, & \dfrac{\partial y}{\partial \zeta}, & \dfrac{\partial z}{\partial \zeta} \end{vmatrix} \quad . \tag{9c}$$

The coordinate transformation equation and the displacement interpolation formula in equation (2) have the same shape function $N_i^{(e)}$.

In planar problems:

$$\begin{bmatrix} x^{(e)} \\ y^{(e)} \end{bmatrix} = \sum_{i=1}^{k} \begin{bmatrix} N_i^{(e)} & 0 \\ 0, & N_i^{(e)} \end{bmatrix} \begin{bmatrix} x_i^{(e)} \\ y_i^{(e)} \end{bmatrix}. \tag{10a}$$

In axisymmetric problems:

$$\begin{bmatrix} r^{(e)} \\ z^{(e)} \end{bmatrix} = \sum_{i=1}^{k} \begin{bmatrix} N_i^{(e)}, & 0 \\ 0, & N_i^{(e)} \end{bmatrix} \begin{bmatrix} r_i^{(e)} \\ z_i^{(e)} \end{bmatrix}. \tag{10b}$$

In three-dimensional problems:

$$\begin{bmatrix} x^{(e)} \\ y^{(e)} \\ z^{(e)} \end{bmatrix} = \sum_{i=1}^{k} \begin{bmatrix} N_i^{(e)}, & 0, & 0 \\ 0, & N_i^{(e)}, & 0 \\ 0, & 0, & N_i^{(e)} \end{bmatrix}. \tag{10c}$$

2. Non-uniform Element Matrix

The theoretical basis for constructing the rigidity matrix and stress matrix for non-uniform elements is the energy equivalence principle and law of mixing of composite materials. The way to create non-uniform elements is to position the reinforcing materials on a line of a series of Gauss points when dividing the subject into finite elements. Hence, the material on these Gauss points has the properties of the reinforcing material and other points have the properties of the matrix. Overall, the element must satisfy the composite mixing law.

$$D_c = D_f V_f + D_m(1 - V_f), \tag{11}$$

where D_C is the equivalent structure matrix of the conventional uniform element. D_f and D_m are the structure matrices of the reinforcing and matrix materials, respectively. V_f is the volume percent of the reinforcing material.

In the following is the derivation of the structure matrix $D_H^{(e)}$ of the non-uniform element based on the equivalent energy principle and homogeneous strain assumption.

Let us use the homogeneous element and non-uniform element structure matrices D_C and $D_H^{(e)}$ $(= \alpha_{pq}D(p \cdot q))$ to replace the matrix $D^{(e)}$ on the right side of equation (5), and then carry out Gauss integration. Let both be equal. We get the following:

$$\sum_p^n \sum_q^n \alpha_{pq}D(p, q)t(p, q)\det J(p, q)W(p)W(q)$$

$$= \sum_p^n \sum_q^n D_c t(p, q) \det J(p, q)W(p)W(q), \tag{12a}$$

where p and q are Gauss point numbers, n is the number of Gauss points, W(p) and W(q) are Gauss integration functions, and t(p,q) is the thickness at a Gauss point (p,q).

In a planar strain problem:

$$\sum_p^n \sum_q^n \alpha_{p,q}D(p, q) \det J(p, q)W(p)W(q)$$

$$= \sum_p^n \sum_q^n D_c \det J(p, q)W(p)W(q). \tag{12b}$$

In an axisymmetric problem:

$$\sum_p^n \sum_q^n \alpha_{pq}D(p, q)r(p, q) \det J(p, q)W(p)W(q)$$

$$= \sum_p^n \sum_q^n D_c r(p, q) \det J(p, q)W(p)W(q), \tag{12c}$$

where r(p,q) is the radial coordinate of a Gauss point (p,q).

In a three-dimensional problem:

$$\sum_{p}^{n} \sum_{q}^{n} \sum_{s}^{n} \alpha_{pqs} D(p, q, s) \det J(p, q, s) W(p) W(q) W(s)$$

$$- \sum_{p}^{n} \sum_{q}^{n} \sum_{s}^{n} D_e \det J(p, q, s) W(p) W(q) W(s). \tag{12d}$$

D(p,q) and D(p,q,s) in equation (12) are functions of the Gauss point. They have different values with different Gauss points. Thus, the elements are becoming heterogeneous. In order to let the properties of this heterogeneous element satisfy the mixing law (11), it is necessary to modify the weighted functions corresponding to all the Gauss points. This is the reason for using the structure factors α_{pq} and α_{pqs}.

By substituting equation (11) into (12) we can obtain the structure factors α_{pq} and α_{pqs} for each Gauss point for the four types of problems described above. In planar strain and three-dimensional problems, α_{pq} and α_{pqs} only depend on the position of the Gauss point and V_f. In planar stress problems, α_{pq} also depends on the thickness t(p,q) at the Gauss point. In axisymmetry problems, in addition to V_f and the position of the Gauss point, α_{pq} also depends on the radial coordinate r(p,q) of the Gauss point.

Hence, the non-uniform element structure matrix that satisfies the mixing law is obtained.

In planar and axisymmetric problems:

$$D_H^{(e)} = \alpha_{pq} D(p, q), \tag{13a}$$

In three-dimensional problems:

$$D_H^{(e)} = \alpha_{pqs} D(p, q, s). \tag{13b}$$

From equation (5), the formula for the non-uniform element rigidity matrix K_{ii} is as follows:

$$K_{ii}^{(e)} = \int_{\Omega^{(e)}} [B_i^{(e)}]^T D_H^{(e)} [B_i^{(e)}] d\Omega, \tag{14}$$

The formula for the non-uniform element stress vector is:

$$\sigma^{(e)} = D_H^{(e)} \left(\sum_{j=1}^{k} B_j^{(e)} d_j^{(e)} \right). \tag{15}$$

III. Stress Analysis at the End of a Synthetic Composition Fiber Rope

The joint and fastening end of a synthetic fiber rope are often the weakest links. In order to fully utilize the load carrying capability of the rope,

we must resolve the fastening problem [3,4]. To this end, we developed a resin reinforced conical end [5]. The fibers were untangled into the shape of a brush and then soaked into a resin. It then solidifies into a frustum end. As an application of the non-uniform element scheme, we used the axisymmetric non-uniform element method derived in the previous section to calculate the stress distribution. A comparison between the results obtained with the uniform and non-uniform model is also made.

1. Material Model

1) Matrix Material: The matrix is polyester. In order to increase its rigidity, a small amount of short glass fiber is added. It is isotropic in nature and its structure matrix is:

$$[D_o] = d_o \begin{bmatrix} d_{11}, & d_{12}, & d_{13}, & 0 \\ & d_{22}, & d_{23}, & 0 \\ & & d_{33}, & 0 \\ \text{symmetric} & & & d_{44} \end{bmatrix}, \tag{16}$$

where

$$\begin{aligned} d_o &= E/[(1+\nu)(1-2\nu)] \\ d_{11} &= d_{22} = d_{33} = 1-\nu \\ d_{12} &= d_{13} = d_{23} = \nu \\ d_{44} &= (1-2\nu)/2. \end{aligned} \tag{17}$$

Based on experimental results, we choose E = 7.0 GPa, ν = 0.34.

2) Fiber Bundle Model: The fiber bundle is an isotropic material in its cross-section. Its axial modulus is much higher than its lateral modulus. Furthermore, it is also much higher than the modulus for the base material. Its structure matrix is:

$$[Q] = Q_o \begin{bmatrix} Q_{11}, & Q_{12}, & Q_{13}, & 0 \\ & Q_{22}, & Q_{23}, & 0 \\ & & Q_{33}, & 0 \\ \text{symmetric} & & & Q_{44} \end{bmatrix}, \tag{18}$$

where

$$Q_0 = E_r/\{(1 + v_{r\theta})[1 - v_{r\theta} - 2v_{zr}^2(E_r/E_z)]\},$$

$$Q_{11} = 1 - v_{zr}^2(E_r/E_z),$$

$$Q_{12} = v_{r\theta} + v_{zr}^2(E_r/E_z),$$

$$Q_{13} = v_{zr}(1 + v_{r\theta}),$$

$$Q_{22} = Q_{11},$$

$$Q_{23} = Q_{13},$$ \hspace{2cm} (19)

$$Q_{33} = (1 - v_{r\theta}^2)(E_z/E_r),$$

$$Q_{44} = (G_{rz}/E_r)(1 + v_{r\theta})[1 - v_{r\theta} - 2v_{zr}^2(E_r/E_z)],$$

The material constants are: E_r = 7.0 GPa, E_z = 70.0 GPa, v_{rz} = 0.034, G_{zr} = 2.61 GPa, $v_{zr} = v_{r\theta}$ = 0.34. The mean volume of the fiber bundle in the entire frustum is approximately V_f = 15 percent.

The direction of the fiber bundle does not coincide with the axis of the cone. The angle between them is composed of the conical angle α and spiral angle θ. After undergoing the two coordinate transformations, the structure matrix under the local coordinate (18) can be transformed to the overall coordinate system.

$$[Q_1] = [T_\theta]^T[Q][T_\theta], \hspace{2cm} (20)$$

$$[Q_2] = [T_\alpha]^T[Q_1][T_\alpha], \hspace{2cm} (21)$$

where

$$[T_\theta] = \begin{bmatrix} 1, & 0, & 0, & 0 \\ 0, & \cos^2\theta, & \sin^2\theta, & -\sin\theta\cos\theta \\ 0, & \sin^2\theta, & \cos^2\theta, & \sin\theta\cos\theta \\ 0, & 2\sin\theta\cos\theta, & -2\sin\theta\cos\theta, & \cos^2\theta-\sin^2\theta \end{bmatrix}, \hspace{1cm} (22)$$

$$[T_\alpha] = \begin{bmatrix} \cos^2\alpha, & 0, & \sin^2\alpha, & -\sin\alpha\cos\alpha \\ 0, & 1, & 0, & 0 \\ \sin^2\alpha, & 0, & \cos^2\alpha, & \sin\alpha\cos\alpha \\ 2\sin\alpha\cos\alpha, & 0, & -2\sin\alpha\cos\alpha, & \cos^2\alpha-\sin^2\alpha \end{bmatrix}. \hspace{1cm} (23)$$

In this calculation, the spiral angle θ = 0.

2. Finite Element Mesh

Quadrangular iso-parametric elements with eight nodes were adopted. Figure 1 shows the finite mesh of the composite frustum. The small end diameter is 38 mm and the large end diameter is 90 mm. The length is 127 mm. Let us

assume that the fiber bundle is located in the second column of elements near the axis and passes the Gauss point whose natural coordinate is $\xi = 0.7746$. The 3x3 Gauss integration technique was employed.
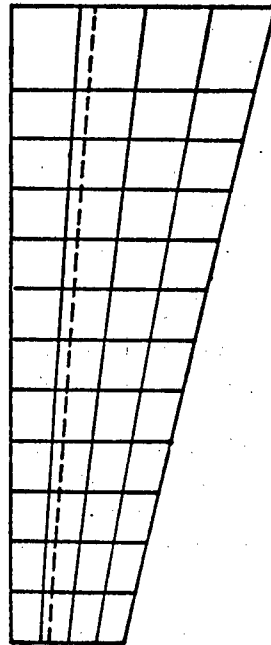
Figure 1. Finite Element Mesh

The boundary conditions consist of displacement and load boundary conditions. The displacement boundary condition is to compute under the following three fixed conditions:

a. The large end of the frustum is fixed.

b. The small end of the frustum is fixed.

c. The entire cone surface of the frustum is fixed.

The load condition is to simulate the load on a rope. Let us assume that a uniformly distributed stress is acting on the two ring elements at the small end near the center. The total load is 1.455 kN.

3. Results and Discussion

a. The stress was calculated in two situations, i.e., with and without any fiber bundles. Figures 2, 3 and 4 show the stress distribution curves in the frustum corresponding to the three fixed conditions when there is no fiber bundle present. The stress value is the mean stress of the elements in the second column. Figures 5, 6 and 7 show the stress distribution curves corresponding to the three fixed conditions with a fiber bundle present. The fiber bundle is located at the second column of elements near the axis. The

fiber bundle stress is compared to the mean element stress. It should be pointed out that the fiber bundle stress should be the stress at Gauss point B (see Figure 8). In Figures 2 through 7, the horizontal axis is the axial distance from the small end and the vertical axis is stress.
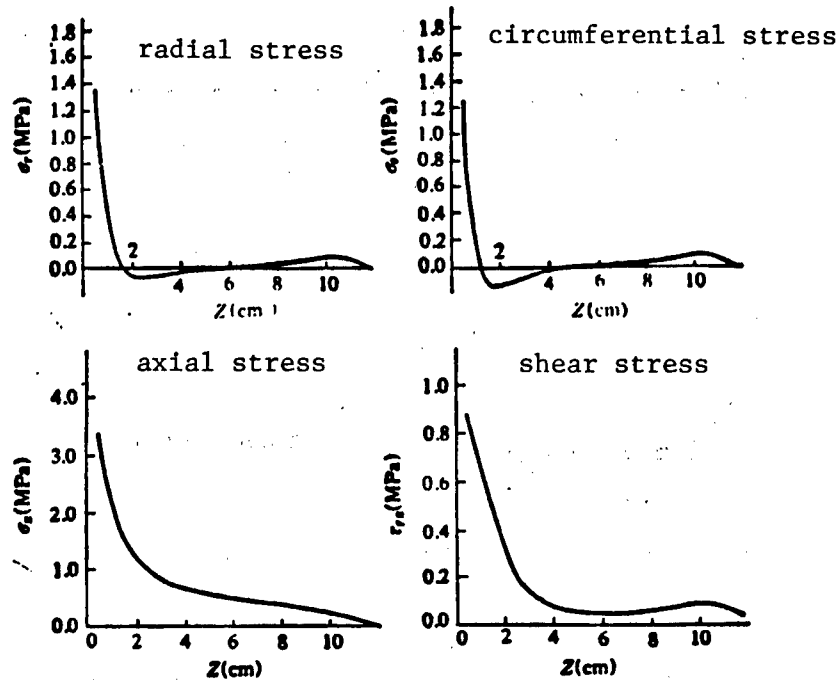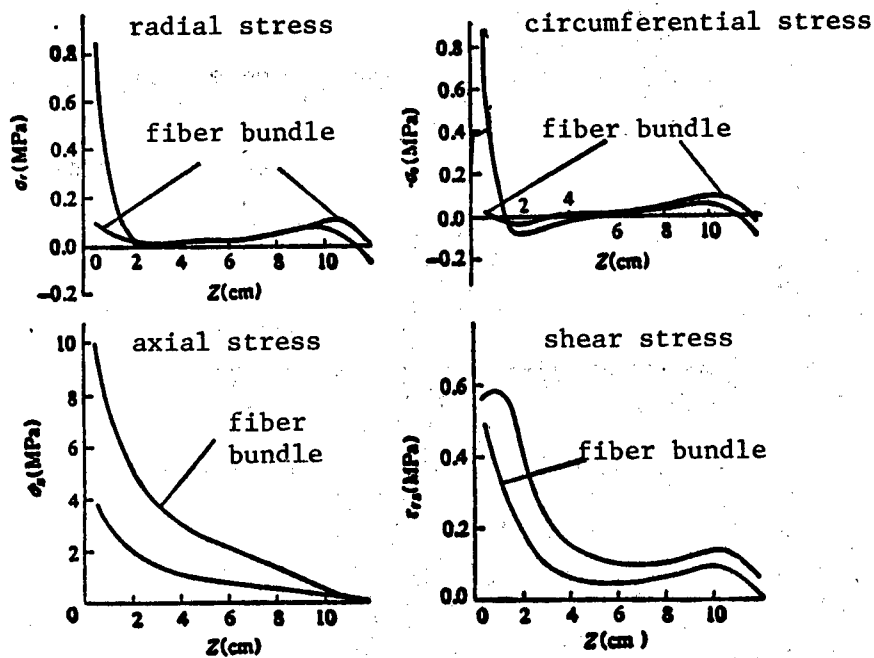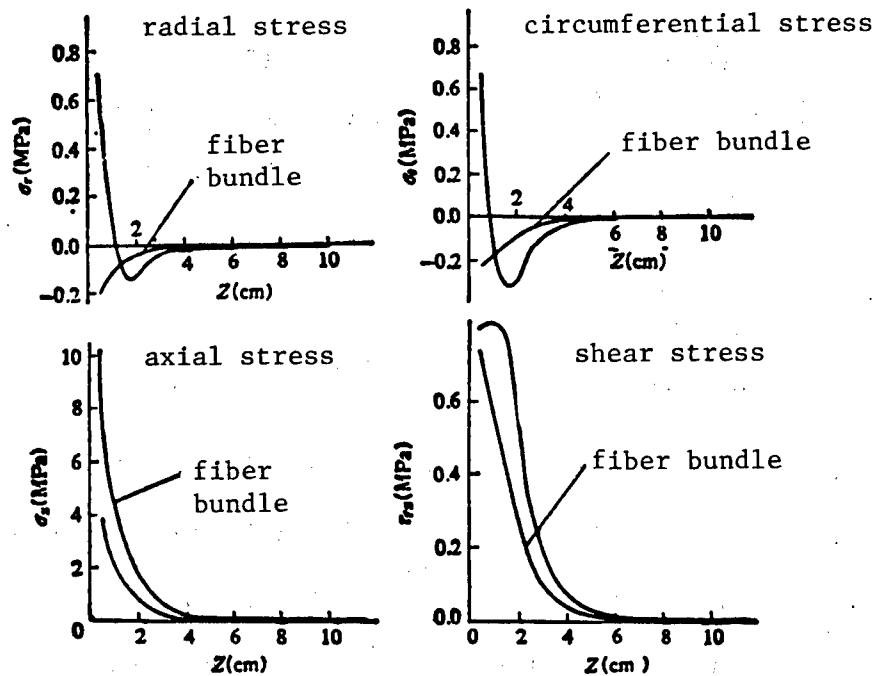
Figure 2. Stress Distribution Without Fiber Bundle (large end fixed)
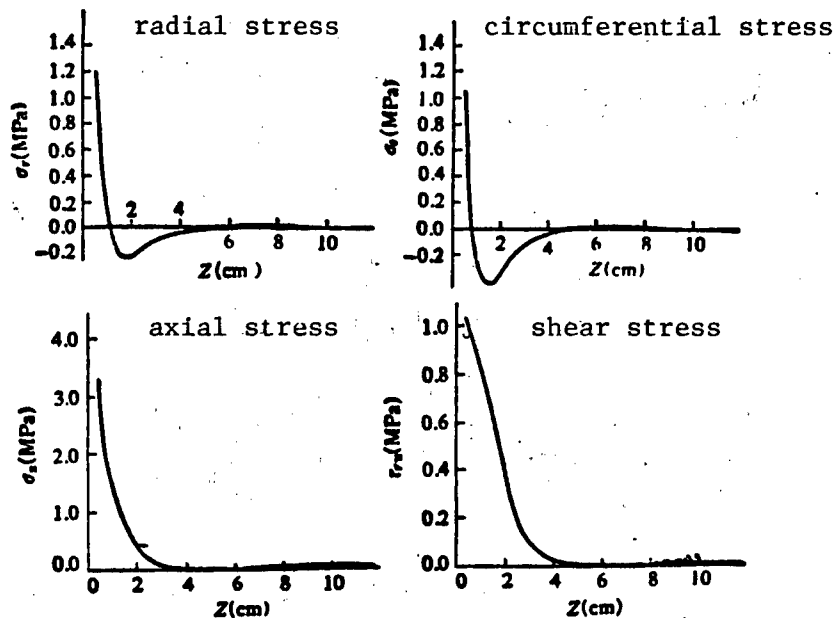
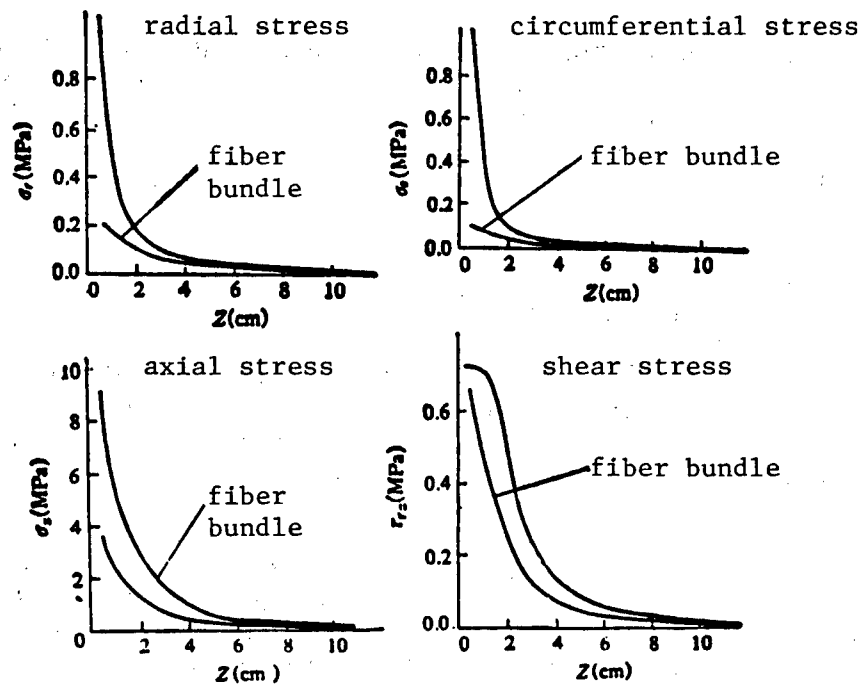Figure 3. Stress Distribution Without Fiber Bundle (small end fixed)
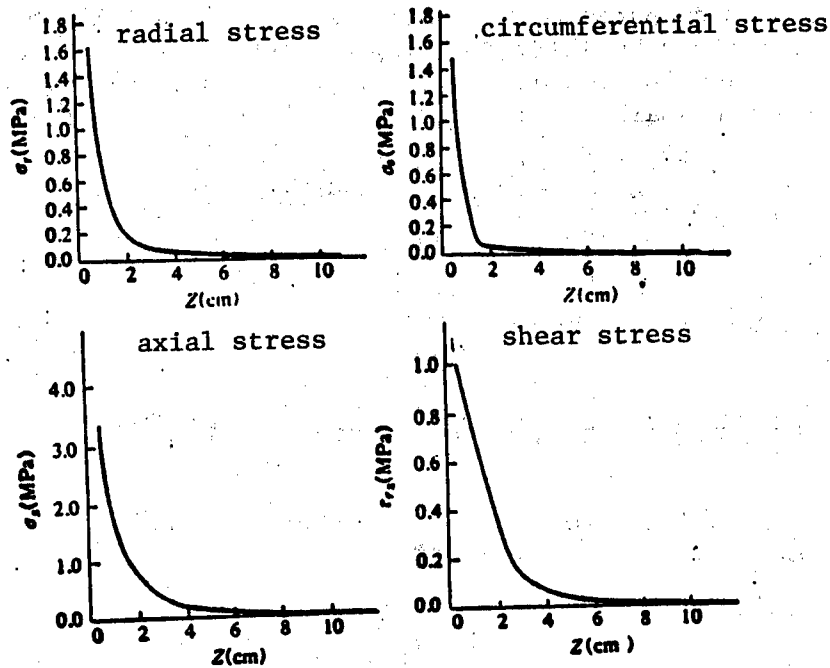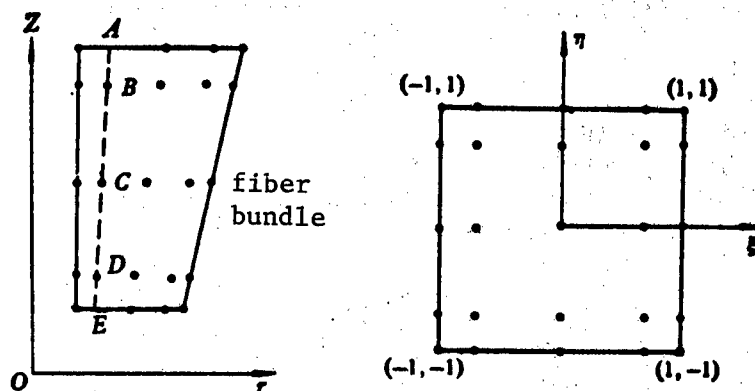
Figure 4. Stress Distribution Without Fiber Bundle (cone face fixed)

Figure 5. Stress Distribution With Fiber Bundle (large end fixed)

Figure 6.   Stress Distribution With Fiber Bundle (small end fixed)

Figure 7.   Stress Distribution With Fiber Bundle (cone face fixed)

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Figure 8. Locations of Fiber Bundle and Gauss Points

It is clear that the stress value at the small end is much higher than that at the large end. Comparing the three curves shows that the axial stress gradient σ_z is much smaller when the large end is fixed. As for the relative magnitude between the stress on the fiber bundle and the mean element stress, the stress on the fiber bundle σ_z is much higher than the mean element stress based on Figures 5 through 7. This is because we assume that the longitudinal modulus of the fiber bundle E_z is 10 times higher than the modulus of the matrix. However, the difference between their shear stress values is very small. This is because the shear modulus of these two composite materials G_{rz} is similar.

b. In order to study the effect of the position of the fiber bundle $r(p,q)$ on stress distribution, we also calculated the stress values at $\xi = -0.7746$ when the fiber bundle is located in the first and third column. The results are listed in Table 1. It should be explained that the volume percent of fiber in each element V_f is 15 percent in all three cases.

From Table 1 it can be seen that when the fiber bundle is very close to the axis, i.e., in the first column of elements, the value of σ_z is much larger than when it is far away. The reasons are: 1) force is evenly distributed on two rings of elements near the axis at the small end; 2) in order to obey the mixing law (11), based on the characteristics of axisymmetric finite elements, the weighted factor α_{pq} becomes bigger as the fiber bundle gets closer to the axis when V_f is constant. Its contribution to the non-uniform structure matrix $D_H^{(e)}$ is larger and vice versa.

c. In order to study the effect of the shape of the end of the composite material to the stress distribution, we calculated a long end case. The length of the frustum was doubled while keeping other dimensions unchanged. Because the relative positions of the Gauss points change in the long and short cases, the stress values at the five points in the element of highest stress are tabulated for comparison. Table 2 shows the non-uniform model fiber bundle stress values. The fiber bundle is placed in the second column of elements. Figure 8 shows the locations of those points. The stress values shown in Table 1 and Figures 5 through 7 are fiber bundle stress values at the Gauss point B.

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Table 1. Calculated Stress Values at the End of a Composite Material

Material model and fiber bundle position	Stress MPa Boundary fixing condition		Large end fixed	Small end fixed	Cone face fixed
Without fiber bundle 2nd column element, stress	σ_z	Mean element stress	3.32	3.19	3.61
	τ_{rz}	Mean element stress	0.88	1.03	0.71
Non-uniform model fiber bundle in 1st row of elements, stress	σ_z	Fiber bundle stress	37.44	34.12	32.87
		Mean element stress	8.21	7.84	7.60
	τ_{rz}	Fiber bundle stress	−1.62	−0.93	−0.59
		Mean element stress	−1.28	−1.05	−0.99
Non-uniform model fiber bundle in 2nd column elements, stress	σ_z	Fiber bundle stress	9.81	8.94	8.53
		Mean element stress	3.79	3.59	3.61
	τ_{rz}	Fiber bundle stress	0.49	0.73	0.65
		Mean element stress	0.55	0.76	0.71
Non-uniform model fiber bundle in 3rd column elements, stress	σ_z	Fiber bundle stress	3.06	1.83	1.65
		Mean element stress	1.08	0.57	0.81
	τ_{rz}	Fiber bundle stress	0.70	1.02	0.87
		Mean element stress	0.69	1.03	0.91

Table 2. Comparison of Fiber Bundle Stress Values With Long and Short Ends

Stress point	Stress MPa	Large end fixed		Small end fixed		Cone face fixed	
		Short	Long	Short	Long	Short	Long
A	σ_z	9.91	7.98	8.89	4.40	8.54	4.75
	τ_{rz}	0.58	0.28	0.86	0.53	0.75	0.43
B	σ_z	9.81	8.24	8.94	4.96	8.53	5.29
	τ_{rz}	0.49	0.23	0.74	0.50	0.65	0.39
C	σ_z	9.87	9.48	9.40	7.54	9.00	7.54
	τ_{rz}	0.06	0.02	0.20	0.27	0.20	0.20
D	σ_z	10.55	11.31	10.70	11.15	10.23	10.43
	τ_{rz}	−0.52	−0.24	−0.50	−0.08	−0.42	−0.04
R	σ_z	10.86	11.95	11.24	12.40	10.73	11.39
	τ_{rz}	−0.72	−0.32	−0.73	−0.21	−0.64	−0.12

Table 2 shows that in all three fixed conditions the stress values at points A, B and C in the long end are smaller than the results with the short end. It is the opposite for the values of σ_z at points D and E. In addition, the maximum value of σ_z goes up when the end is lengthened, which is bad for strength.

IV. Conclusions

1. This paper presents the non-uniform finite element concept. Starting from the pseudo-work principle, assuming uniform strain, the non-uniform rigidity matrix and stress matrix equations for four situations were derived. The element not only meets the energy equivalence principle but also satisfies the mixing law for composite materials. It is very effective in calculating the stress distribution in sparsely reinforced composite material. The results are much more accurate than using the conventional uniform element method. In plane stress problems, such as a loosely ribbed plate, this element can also take the inhomogeneity of thickness into account.

2. As an example with non-uniform element, the stress distribution on the end of a rope was calculated. The curves obtained fully demonstrated the superiority of the non-uniform element.

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